TOPICS OF THE MONTH

Chemical engineering research

AT the time of its annual general meeting last October, the Association of British Chemical Manufacturers announced its intention of setting up a Chemical Engineering Research and Advisory Service Committee, following the Department of Scientific and Industrial Research report of the Cremer Committee on chemical engineering research. The committee has now been appointed and has started work. The chairman is Mr. E. W. Greensmith, of Imperial Chemical Industries Ltd. The A.B.C.M. members are Dr. J. W. Barrett, of Monsanto Chemicals Ltd.; Mr. F. Mackley of Shell Chemical Co.; Mr. K. Piercy, of Albright & Wilson Ltd.; Dr. L. Roffey, of Distillers Co.; and Mr. B. E. A. Vigers, of Laporte Chemicals Ltd. The British Chemical Plant Manufacturers' Association have appointed Mr. G. A. Dummett, of the A.P.V. Co. Ltd. and chairman of the Association's research committee, as its liaison member. Dr. E. H. T. Hoblyn, the director of the British Chemical Plant Manufacturers' Association, and Mr. J. Davidson Pratt, director of the Association of British Chemical Manufacturers, are *ex officio* members.

On the recommendation of the committee, Mr. Trefor Davies, B.SC., F.R.I.C., M.I.CHEM.E., has been appointed as its technical executive officer.

Activated carbon factory for Northern Ireland

A NEW factory for the production of activated carbon from peat has been opened in Northern Ireland. The new enterprise represents the first production of activated carbons from peat in the United Kingdom, although large quantities of this special type of carbon are annually imported from foreign countries.

Powdered decolorising carbon will be produced by a new process utilising a high-temperature, fluid-bed technique. The project has been engineered by the British Ceca Co. Ltd., of London, who will also market the products of the factory. The factory will be operated by a new company, Ceca (Northern Ireland) Ltd., which was formed for the purpose with participation of Charles Tennant & Co. (Northern Ireland) Ltd., and the project follows an extensive three years' survey carried out by the Department of Industrial and Forensic Science of the Northern Ireland Government on the peat deposits available as raw material.

The new project is of particular interest, since it utilises a raw material available in Northern Ireland which hitherto appeared of little value. Activated carbon produced from peat has particular qualities which make it of special interest in certain branches of the chemical and food industries.

Rubber and chemicals from oil at Fawley

THE construction of a £9-million chemicals-from-oil plant is involved in the Esso Petroleum Co.'s plans to produce raw materials for Britain's first full-scale synthetic rubber plant at Fawley. The new plant, which is expected to be completed in 1958, will process nearly 250,000 tons p.a. of crude petroleum into a large volume of chemical materials, including ethylene, propylene, butylene and butadiene.

Butadiene from the new Esso plant will be fed to the new £5-million factory shortly to be built on an adjacent site by the International Synthetic Rubber Co., formed by Dunlop. Output from these two plants will provide 50,000 tons of GR-S rubber annually—roughly equivalent to the present total volume of Britain's GR-S rubber imports from the U.S.

Clearly this is by no means the whole story, and there is now scope for building up a considerable amount of activity in plastics production in the vicinity of the Fawley refinery. Meanwhile, it is good to note that Britain's plans to produce her own synthetic rubber are bearing fruit and that a new source of home-produced raw materials will now become available to key industries.

Italy's chemical industry from within

THERE is a fallacious idea concerning the high duties which are thought to protect Italian industry and the chemical industry in particular, according to Signor P. Giustiniani, managing director of the vast Montecatini chemical concern. As an example he points out that in 1954 dyestuffs were imported into Italy for a declared value of 3,723 million lire, the selling value of which is equal to at least 30% of total Italian consumption, although national production is able to meet the total requirements of the consumer industries. Italian duties are quoted as varying from 15 to 20% as against 25 to 30% in France and 40% in the United States. Signor Giustiniani claims that in France and in Britain importation entails a long and wearisome procedure. Taking titanium dioxide as an example, he compares the duty in Italy, 13% of the value, with 15% in the U.S., 25% in France and 33⅓% in Britain. The duty in Italy on hydro-sulphite is 21% (30% in France, 33⅓% in Britain and 35% in the United States).

Montecatini's managing director makes these comments in an Italian survey which appeared in the *Manchester Guardian* last month, and points out that chemical products were among the first to feel the effects of Italy's policy of freeing imports. This policy, which, unfortunately, he adds, has not been followed by other important producing countries, has forced Italian products to stand up to some lively foreign competition in the home market.

Signor Giustiniani preceded these comments with a brief survey of the Italian chemical industry. From this it appears that the number of chemical undertakings has risen from 4,500 in 1938 to 5,500 in 1955. In all, these employ today 173,599 persons, compared to 120,863 in 1938. The total value of chemical production has risen to 500 billion lire (£300 million), an increase of 160% over the 1938 value, which was 190 billion lire (estimated at the present value of the Italian lira).

The index of chemical production (1938 = 100) has risen to 280 in 1955. The production of chlorine in 1955 was over 100,000 tons, as against 29,000 tons in 1938; electrolytic soda was 110,000 tons as against 32,000 tons in 1938; and sodium carbonate rose from 352,000 tons to 470,000. A notable leap has been made in the production of synthetic nitrogen, which has risen from 93,000 tons in 1938 to 350,000 in 1955. This rapid progress is partly connected with the new prospects opened by the discovery of resources which had long been the object of confident search.

There is naturally a reference to Italy's growing petrochemical activities, and the ' spectacular ' progress in the field of plastics is also noted. The production of phenolic and ureic moulding powders, which was developing at a rapid rate, has been integrated with that of more recent plastics materials such as polyvinyl chloride (better known in Italy as *Vipla*), polyvinyl acetate, polystyrene, polythene, polyesters, malamine, and fluororganic plastics.

Future plans contemplate the production of synthetic rubber and there is also mention of the plans to set up plant at Ravenna for the production of Buna S or GR-S with a productive capacity of 30,000 tons, starting from acetylene produced from natural gas.

Finally, there is a reference to the fibres industry, and it is stated that Italy produces today all the synthetic fibres known in the world. Improvements in acrylic fibre are being studied in order to improve sales on the basis of experience in other markets. Lastly, the production of *Terylene* and *Dacron* began recently on a large industrial scale.

Shale oil industry's doldrums

A FURTHER contraction of the shale oil industry in Scotland has been indicated by Scottish Oils Ltd. Recently the company announced the closing of the Roman Camp works near Broxburn, and their supplying mines—a plan which has already been effected; now it is announced that steps will be taken to stop production at Addiewell works, Bathgate acid works and Burngrange Pit, West Calder.

The position now facing the shale oil industry is increasingly difficult; competition from petroleum has intensified and has decreased the scope and price available to shale oil products. From a peak of 3,250,000 tons of shale in 1913 from 10,000 workers, the industry has contracted to 1,200,000 tons and 3,500 workers. The preferential 1s. 3d. per gallon in excise duty on motor spirit and diesel oil for road vehicles has assisted, but has been more than wiped out by rising costs.

Producing new plastics by ' chemical grafting '

SCIENTISTS at the laboratory of the Faculty of Sciences of Paris have developed a technique which, it is reported, makes possible a systematic production of an immense variety of new plastic materials. The new process consists in what is termed a chemical grafting of one plastic material on another, bringing about the closest integration and the production of a new, perfectly homogenous material. By varying the materials used, it is stated, an infinite variety of entirely new plastics becomes possible.

X-rays play an important part and have the effect of increasing the size of objects made from the new process by as much as ten times. Another interesting point is that the product of grafting of two plastic materials produces a third whose qualities are far superior to those of the two original materials.

Already a number of French chemical production firms are taking an active interest in the new invention. Specimens of many varieties of entirely new plastics are being shown at the Foire de Paris, the Paris annual international trade fair, this month.

Centenary of a chemical cleric

THE organic chemical industry producing intermediates by use of catalytic hydrogenation owes much to Jean Baptiste Senderens, born 100 years ago in the High Pyrenees. No two names in chemistry are more closely linked than those of Paul Sabatier and Senderens for, like their countrymen Dulong and Petit in pure chemistry, these two Frenchmen became noted for an equal share in advancing our knowledge of catalysis and in applying it to industrial use. They were the first to recognise nickel as an invaluable catalyst, their first laboratory experiments having such a catalyst within an oil-bath type of heater.

By 1901 their first patent opened up the motif of hydrogenating organic compounds, the specification including such metals as cobalt, iron and palladium as well as nickel. In 1905 their joint paper in the *Annales de Chim. et de Phys.* gave a lengthy survey of the preparation and uses of such catalysts, of the need for excluding air during preparation, of the use of oxides free from traces of sulphur and chlorine, and of the periods of normal activity and subsequent decline of catalysts. In collaboration with Aboulenc in a later paper the peculiarities of nickel catalysts were reviewed, with a mixture of metal plus oxide partially reduced proving more active, a point developed later by Ipatiev.

Coming to applications which have proved invaluable to industry, we find Senderens being especially interested in technical or industrial possibilities in association with Poulenc Frères. He noted how nickel lost activity after long use in hydrogenating phenols, and how cyclohexanol could be produced in bulk from hydrogenating phenol. Senderens was particularly successful in working on the vapour-phase catalytic processes, and was one of the first to put forward the intermediate compound theory of catalysis. Apart from his work on hydrogenation, Senderens

also studied such catalytic oxidations as that of toluene to benzoic acid and catalytic dehydrations such as ethyl alcohol to ethylene (which today is a standby or reserve source of ethylene at Amlwch in Anglesey).

While Paul Sabatier should not be confused with his contemporary of the same name, who was a literary figure, Senderens became first an abbé and then a canon. All of which reminds us how his catalyst became to laconic Americans 'the chemical parson,' since 'it unites two things together, but is unaffected by the change.'

Self-lubricating metal

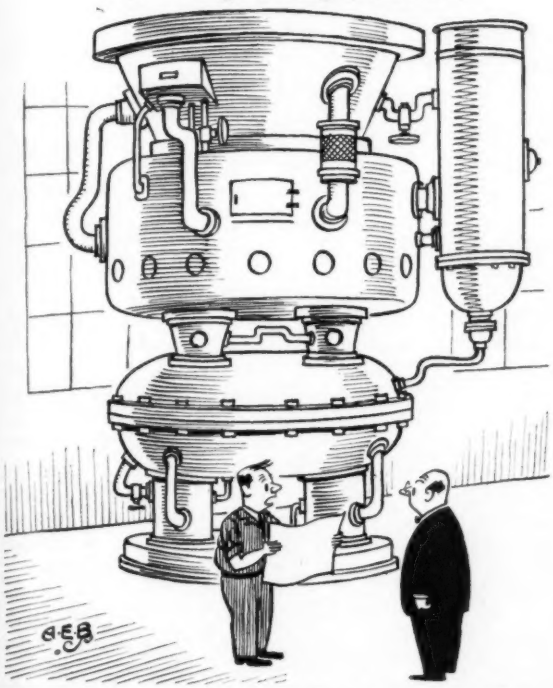
EXPERIMENTS with a self-lubricating metal called *Deva* are being carried out by the Symington-Gould Corporation, U.S. This company, manufacturers of railway equipment, are also investigating the possibility of making castings to shape from titanium.

The self-lubricating metal is a product of powder metallurgy. Fine metal powders and graphites are compacted into fully dense, solid, machinable metal which, it is stated, retains its self-lubricating qualities even though worn paper-thin. Tests include jet engine seals, piston rings, liners and bearings. *Deva* metal is expected to have a wide commercial market where lubricating oils and greases are detrimental to product processing, such as textiles, paper, veneer woods, and food-processing machines.

The process, on which Symington-Gould have an option in the U.S. and Canadian manufacturing and sales rights, can be applied to iron, bronze, nickel and other metals. It is said that temperatures ranging from as low as –290 to as high as 1,250°F. are withstood.

Regarding titanium, Symington say that if current investigations prove fruitful they may install melting and processing equipment for making titanium and other super-alloy castings during 1956.

Comical Engineering Situations



"KNOW SOMETHING, BOSS? — I THINK WE'VE INSTALLED IT UPSIDE DOWN."

New record for European steel production

EUROPEAN crude-steel production in 1955 (including the U.S.S.R.) totalled 138,883 million metric tons, a 13% increase over 1954. It thus again broke all previous records, as it has done in each successive year since 1949, when the 1937 record was exceeded for the first time.

Production exceeded 4 million metric tons in the following countries: U.S.S.R. 45.2 million tons, Western Germany 21.3, United Kingdom 20.1, France 12.6, Belgium 5.9, Italy 5.4, Czechoslovakia 4.8 and Poland 4.5. Production in Western Germany during the year surpassed the best previous annual production, attained in 1938, for the first time, and Western Germany took the second place from the United Kingdom as Europe's largest steel producer after the U.S.S.R. Similarly, Italy took the sixth place from Czechoslovakia and Yugoslavia the 17th from Rumania.

The greatest relative increases in production occurred in Yugoslavia, Italy and Western Germany, where production was up by 29, 28 and 22% respectively, compared to the previous year. The more important absolute increases in production over 1954 ranged from U.S.S.R. 4.2 million tons, Western Germany 3.9, France 1.9, United Kingdom 1.3 to Italy 1.2.

Crude-steel production in both the United States and Japan was also a record, attaining nearly 106 million tons in the first case and almost 10 in the second. Production compared to 1954 was up 32% in the United States and 26% in Japan. However, 1954 was a relatively poor year for steel production in the United States, and the 4% increase over the previous record year's production in 1953 provides a better indication of the trends of production.

These facts are revealed in a survey* issued by the United Nations Economic Commission for Europe, which gives foreign-trade figures for the first 10 months of 1955 to indicate that during the three months of August, September and October, exports of finished steel from all of the main West European countries were at a higher rate than in any previous post-war year, except in the case of Austria, where they were slightly down on the 1954 figures. The same statement holds true for the first seven months of 1955, compared to which the August to October exports rose in the case of Belgium-Luxembourg and the United Kingdom, remained constant in the case of Austria and fell in the case of France/Saar, Western Germany and the Netherlands.

* 'Quarterly Bulletin of Steel Statistics for Europe.' H.M.S.O., 7s.

A tale of two chemists

ROGER and Thomas are identical twins and, during the early part of their lives, close companions. Following their usual habit of doing everything together, they enter a university and eventually both take their M.SC. But Roger takes his in physical chemistry, Thomas in organic. Thus, as they both enter the British chemical industry, the twins pose a most unusual test for the industry as an employer. Can it assimilate two men of identical outlooks, attainments and qualities, and yet give them scope for individual development, progress and reward?

Roger spends his first nine months in the chemical industry doing fundamental research in physical chemistry, then examines the processes and types of machinery needed for the manufacture of a completely new product. This necessitates the systematic planning of experiments carried out in a small-scale plant, and he spends an evening a week studying applied statistics at a London college. After two years he has enough practical experience to be able to assist in the establishment of a similar pilot plant in Canada, where he works a further two years. Eventually a big factory is built to incorporate the results of his research. He is invited to change over from research and development to production management and to help start up the new factory.

Thomas's first job is the investigation of high-pressure polymerisation, but after nine months he is working with a team of graduates on the development of a process from the laboratory to plant scale. After a further nine months he is transferred to another project where he is responsible for the development and improvement of an existing process. Most of the work is on a small scale, but large-scale tests on the production plant are necessary from time to time. He has much experience of many and various problems and it is not surprising that he is then transferred from development work to the production side of the industry. He is promoted to a new factory making a new product—the factory at which Roger has arrived by his different route.

With this illuminating example, a careers booklet issued by the Association of British Chemical Manufacturers shows how two young men can enter the industry with good qualifications and, though their paths diverge and for five years their work and experience range over widely different fields, eventually come together again in responsible key positions with no more than a small difference in salary. Here indeed, the booklet points out, is evidence of the exactitude with which the chemical industry judges its men and of the skill with which it matches individual talent with fitting opportunity and reward.

The booklet, which is attractively presented and illustrated, has been produced to help young people to make up their minds about a career, and aims to encourage them to think about the British chemical industry. It is entitled 'The Chemical Industry Calling You' and contains a number of examples, in story form, of both technical and non-technical careers in the industry.

Chemical and plastics projects in Brazil

THREE new factories for the production of chemical products and insecticides are to be set up in Brazil by the Bayer concern, Germany's largest producer of chemicals and pharmaceuticals. The projected factories are to be built on a 300,000-sq.m. area near Rio de Janeiro. One will produce dyes and textile auxiliaries, the other will transform chromium ore to chromates, and the third will produce insecticides. Factories for the production of tanning substances and other chemical specialities in Brazil are also envisaged.

Significant for the development of Brazil's plastics industry was an earlier announcement, this time from New York, that the Borden Co. was launching a $3½-million expansion programme which will give Brazil its first methanol plant and substantially increase its production of formaldehyde and synthetic resins. The programme, scheduled to be completed in 1958, is being undertaken by Alba S.A., a chemical firm in which Borden International Ltd. is a majority stockholder.

Among other American firms active in Brazil at present are Celanese Corporation of America and the Columbian Carbon Co., who have jointly announced that a site has been purchased near Santos, Brazil, for the erection of a furnace-type carbon-black plant with an annual minimum capacity of 30 million lb. The plant will be built by Copebras (Companhia Petroquimica Brasiliera).

Yugoslavia's Majdanpek project

THE recent Soviet offer to help Yugoslavia carry out her Majdanpek industrial project, coupled with current high world copper prices, have once again brought this plan to the fore. It was in the news two years ago when Japanese experts visited the country to study ways of increasing its output of metal ores, under the auspices of the United Nations' Technical Assistance Programme. In the meantime France, with U.S. backing, had offered to help by supplying machinery and plant on a credit basis with repayment to be made over five years in copper produced in the new installations.

This complex industrial project foresees the following undertakings:

Setting up an open-cast mine and construction of a flotation plant at Majdanpek (eastern Serbia) with an annual treatment capacity of 3.6 million tons of ore.

Construction of a new smelter and of a sulphuric acid plant at Bor, the smelter having an annual capacity of 55,000 tons of copper (30,000 tons from Bor and 25,000 tons from Majdanpek) and the other facility having an annual capacity of 230,000 tons of sulphuric acid.

Construction of a plant at Prohovo on the Danube which would use the sulphuric acid from Bor to produce about 575,000 tons of superphosphates annually.

Construction of the necessary rail links and expansion of the harbour at Prohovo.

THE MOVEMENT OF MATERIALS IN INDUSTRY

By C. C. H. Brazier, O.B.E., T.D., M.I.MECH.E., M.I.CHEM.E., F.G.S., M.CONS.E. *

Many industrial undertakings, while always willing to spend time and money on improving their manufacturing processes, fail to realise how much they lose by their neglect of the important subject of efficient materials handling. In the chemical industry, for instance, there is still plenty of evidence of inefficient handling methods. It is wrong to think that the principles of mechanical handling are applicable only to mass production and packaged goods—they apply to the movement of all *materials whether solid, liquid or gaseous. These and many other points are touched upon in this article, which puts the case for improving methods of handling and discusses some practical considerations, including costs.*

MAN'S activities can be divided into (*a*) making things and (*b*) moving them about during and after the process of making. The same generalisation is true of all industrial processes. Thought, attention and much ingenuity has been continuously expended upon the processes of manufacture; the strange thing is that the second task—the movement of materials and things—has not received the same concentration of thought as the process of manufacture, in spite of the expenditure of labour and effort involved.

No apology is offered for repeating the above statement, made by the author on a previous occasion,[1] for, while many manufacturers do undoubtedly give considerable thought to the movement and handling problems within their plants, works can still be found where scant regard is paid to this feature of the process. Not infrequently, the waste of labour and effort is defended by the remark that: 'We make a profit, so why worry?' The answer is, of course, that the time may come when increasing labour costs or market conditions have done away with the profit margin. Surely the wise course would be to save waste, reduce costs, and reduce the price of the commodity to the customer; failure to do so is not only unethical, but bad business. For, whatever arrangements there may be for price fixing for the time being, the laws of supply and demand must ultimately prevail. The comfortable price margin of today may well become an uncomfortable debit tomorrow.

In the face of constant high-level appeals for greater efficiency in the deployment and use of manpower, it seems strange still to find plants where the economics and labour of handling materials either is not recognised or is passed over. Already the Government, through the appropriate Ministry, is bringing pressure to bear upon those users of fuel who disdain combustion efficiency; the time may not be far distant when the use of manpower in industry will stimulate a further drive for curtailment in all but essential tasks. Very few man-handling operations, as applied to moving things about, could be justified as essential.

*Brazier & Partners.

Handling costs

Investigations at a number of plants indicate that handling costs can be anything from 15 to 70% of the process cost. It has been stated that in Britain about £800 million is spent each year on materials handling, of which it has been estimated at least 30% could be saved by revision of methods.[2] Without either challenging or seeking to substantiate this statement, it is fairly obvious that the national expenditure for the service is vast, as indeed are the prospective savings. In processes using heavy tonnages of raw materials and where simple treatment obtains, the process is practically a question of movement and little else, *e.g.* in rock, gravel and suchlike plants. At the other end of the scale is a factory producing highly priced articles where the cost ratio of making and movement is reversed; even so, a revision of handling arrangements may reduce bottlenecks in production and enable the process machiners to earn more by a steady (or accelerated) throughput of units of production, resulting in reduced cost of production.

In point of fact, the need for increasing production is a frequent spur to the solution of handling problems in general and the actual cost of movement is secondary to the overall cost of production; process and movement being interdependent, the problem is not always solely confined to handling costs.

It sometimes happens that the system of allocation of costs in use at a plant, upon which the cost sheet is based, whilst revealing stage by stage production cost, does not disclose the actual cost of movement of materials in and about the process. Hence the use of not-so-efficient methods of handling, or equipment employed for the purpose, may escape the notice of management. In some large concerns the cost of handling is dissected in great detail in the accounts and, whilst such regular analysis may or may not be justified for all plants, at least a periodic review of methods and costs of movement of materials can be rewarding. Unless the need for such a study is appreciated at the top, it is doubtful whether improvement of method will filter through from the executives upwards. A busy plant executive is invariably loaded with the day-to-day tasks of 'making' the product.

Wide scope of mechanical handling methods

Much investigation, research and reporting upon the subject of materials handling has been carried out both at home and abroad, notably in the U.S., as witness a report[3] issued by the O.E.E.C. on the findings of a visiting team who studied the methods employed by American industry to cut the costs of handling and movement.

The James Clayton lectures before the Institution of Mechanical Engineers[2] in the same year are another example, likewise various papers issued at exhibitions and meetings held in London.[4] But, in spite of the large amount of written matter on the subject and the papers discussed by engineering societies and institutions, it seems that the advantages to be gained by mechanical handling do not seep through to some sections of industry.

Whatever the prime reason for this may be, at least one reason is the belief that mechanisation of movement is mainly applicable to mass production and in particular packaged goods, *e.g.* safety razor blades, confectionery, etc. At the risk of stating the obvious, it should be noted that the same general principles apply to the movement of *all* materials, whether liquid, solid or gaseous; whether as raw materials during manufacture or in the finished state. It is only the extent to which these principles can be gainfully applied which varies from plant to plant. In the chemical industry the producing units are usually well designed and proportioned for service requirements, as might be expected, but the same cannot always be said of the handling methods used in and around plants—particularly in the movement of solids within the process. A contributory factor in many older works is that extensions have been made to the original plant, or processes have been modified, which has resulted in a tangle of conveyors and elevators supplemented by manual labour in varying proportions.

Assessment of handling costs

It is suggested that a critical study should be made of the methods employed at a works, by an executive detailed for the purpose, in order that the management can accurately assess the capital cost of any revision and balance the savings likely to accrue from the changeover. Any proposal for revision of method invariably postulates three questions:

(*a*) Will it increase production?
(*b*) Will it reduce the cost of the production?
(*c*) Will it improve the quality of the product?

The proposal must stand or fall upon the answers to these questions. The three considerations are interdependent, *e.g.* it may pay to invest capital in handling equipment without any direct saving in movement costs if thereby the overall output of the plant is increased (*a*). Cases have occurred where the installation of suitable equipment has resulted in the prevention of damage to a product during movement and so justified the expenduture (*c*).

The cost of moving materials (and things) can be analysed into 'fixed costs,' which includes interest on capital investment, rent, insurance charges, etc., and 'variable costs' such as labour employed, power charges, etc., which vary with the tons per hour, or units of production which have to be handled. The 'variable costs' is usually the dominant factor in deciding the *type* of equipment for a particular case, *e.g.* with a steady, well-balanced throughput more expensive equipment is justifiable than in a case where there are wide and frequent fluctuations in throughput, as in some batch processes.

There is a third category of costs, *i.e.* 'semi-variable charges' such as inspection and supervision, but these charges do not often affect the consideration of handling proposals.

A useful approach to the economic factors when considering a revision of method is to plot the known costs of the existing arrangements together with the estimated costs of the revision proposals, money against throughput as illustrated. The range of throughput should cover normal plant variations, although there is usually one point on the base line which determines the issue, for or against.

The approach to improvement of existing handling methods

The preliminary requirement before any realistic approach can be made towards improvement of method leading to saving of money and/or manhours is a knowledge of *all* the factors. The temptation to go to the drawing board with an 'obvious' solution should be resisted; the result may be wrong, or at least not the best solution. The information necessary is the weight, bulk of material (or size of items), the rate at which it must be moved from stage to stage, interprocess storage needs—as in batch processes—plus safe marginal stocks of raw materials inwards and of the finished product outwards (including bagging or packaging) where applicable. The physical nature of the material, possibly including temperature, together with any particular hazards from fire, or toxic effects, naturally affect the correct choice of method and equipment. Likewise the cost of labour, power and other external services utilised.

Much of the cost data is readily available within works; *per contra*, much has to be established owing to peculiarities in local methods of allocating and posting charges. For instance, the cost to the company of man-hours is not simply a multiple of an hourly rate but must include a quota for National Health, holidays with pay and suchlike additions. The power charges may be subject to additions for increase of maximum demand payments. Maintenance costs, embracing both labour and consumable stores, spare parts, etc., vary greatly and need analysis, *e.g.* the wrong type of existing conveyor or elevator may appear innocent of waste until the aspect of renewals is investigated.

Time spent upon a study of existing methods is rarely wasted and, when all the factors have been tabulated, the problems of improvement and revision can start from fact and free from assumptions.

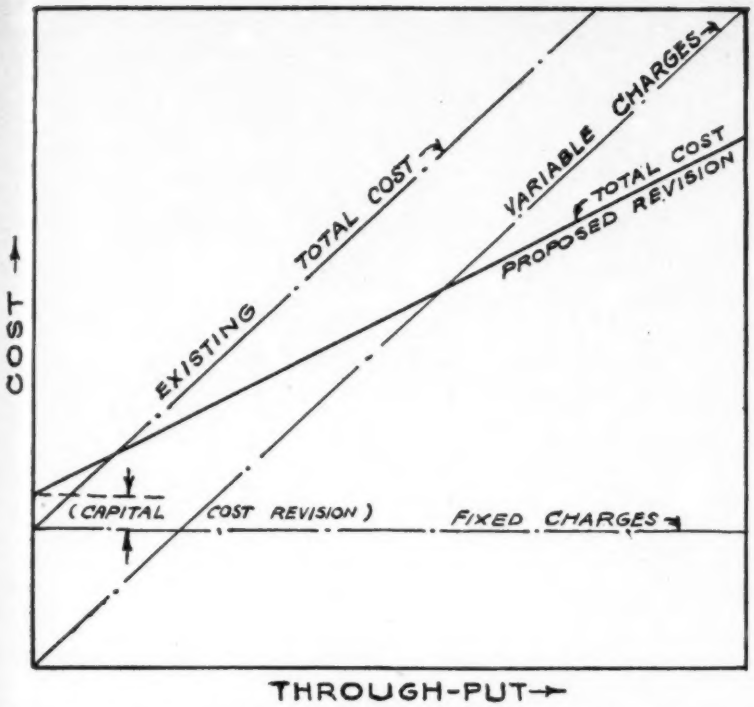
Much has been written about the ideal *pro forma* for recording movement data, with appropriate symbols for this and that operation, more particularly in plants handling mass-produced items. Whilst this subject is outside the scope of these notes, the writer would stress that for the purpose under consideration the 'form' in which the factors are recorded is less important than the use made of the information by the management.

Practical design of materials handling system

The design of a materials handling layout to cope with all the factors is obviously a question of the shortest flow possible, having regard to the practical possibilities of the case in point. In the case of an entirely new project the designer has a clear field (apart from site restrictions). The natural tendency is to site the producing units along or around the conveying system, the handover from one stage to another being reduced to a minimum, either in a linear movement, or in elevation to feed hoppers.

This trend has produced the cliché that the ultimate solution to any movement problem is to so arrange the producing units that all handling is obviated; an over-simplification in most cases, but an objective to be kept in mind.

In the case of existing plants with site restrictions, unusually shaped buildings and extensions which have been joined on from time to time—and not infrequently changes within the process used in the industry—the revision of method and equipment throws up more involved problems. Against this it is only fair to point out



Example of graph, as suggested on opposite page, showing economic factors involved in a proposed revision of handling methods.

that systems for movement of materials are very flexible and it is both possible and economic to go underground, overhead, around corners and to pass from building to building (not necessarily adjacent blocks).

A study of all the data leading to proposals for a revision of methods can be approached from: (*a*) consideration of a flow sheet of the process; (*b*) a plan of the plant showing buildings and existing layout of producing units, bunkers, stores, etc.; and (*c*) a movement diagram, which can be a print of (*b*) with direct arrow-headed lines of movement pencilled thereon. Cardboard cut-outs to fit the scale plan can be useful to try out ideal and compromise solutions. With all the requirements and limitations in view, the logical solution can be deduced and set out on the drawing board.

There is nothing very 'technical' about the whole study, it is mainly a question of common sense and application of engineering principles, plus an understanding of the type of equipment which is applicable to the job. The latter point is, surprisingly enough, often a stumbling block; it may be that the busy executive is too immersed in the daily round of production to keep abreast of developments in handling methods, in spite of the pages of advertisements and descriptive matter in the technical journals. In America, as is their custom, they have developed specialists—'materials handling engineers.' Without further comment upon this additional specialisation within the profession, the writer feels that movement problems and technique is within the province of the engineers who operate the intricate machinery and plant of modern industry.

Some types of handling equipment available

Basic raw material movement, usually involving large tonnages, may be effected by the use of road vehicles of the self-tipping varieties (of which there are many types) by rail on standard or reduced gauge with a range of locomotives and (short) haulage arrangements. Aerial ropeways show to advantage where the intervening country makes other forms of haulage prohibitive in capital cost. All forms of overhead transporters which unload from waggons or vessels, segregate and desegregate the material as may be required, in and out of stock, before ultimate use. Derricks, jib cranes (both mobile and fixed), overhead travelling cranes with grabs operating over bunkers and feed hoppers, hoists, waggon tipplers and similar equipment have a large field of application. Conveyors, both within and external to the plant, are built for a wide range of tonnages, materials and speed of operation.

Probably the belt conveyor is the backbone of conveyance in industry. It may have rubber-bound duck plies, duck, plastic or steel bands, according to service requirements. The driving head, tensioning device and supporting rollers are available to almost any specification; likewise supporting structures, for horizontal or inclined application.

Steel slat conveyors, with or without articulated sides, offer considerable scope for the movement of heavy, abrasive, or hot materials, and give satisfaction providing the dimensions and speed are properly designed (which remark could be applied to most mechanical contrivances).

Chain conveyors, both above and below ground, are designed to carry an almost endless variety of attachments ranging from mere drag plates, for the movement of materials like sand, to all sorts of fixed or swinging trays and attachments capable of handling anything from quite small items to motor-car bodies passing through spraying shops.

The compressed-air systems, such as the Fuller Kenyon pump, air slide conveyors, etc., are applicable to a wide range of powdered or granulated materials. Power-driven trucks, with or without lifting and stacking facilities (the latter styled 'fork lift' trucks) are widely used throughout industry, and have many useful fields of application holding stacked items, bales, etc., to finished items of production. Gravity roller conveyors for packages and the like are widely used in handling operations; even so, their usefulness is often overlooked.

Most of the equipment mentioned, item by item, can be obtained with wide variations, both as regards capacity, performance and, of course, cost.

It is hoped that the above recapitulation of equipment available will serve to broaden the horizon of those still surrounded by uneconomic methods of handling and movement of materials or to stimulate a critical review of the less satisfactory parts of a plant.

Need for more interest in handling

In those industries where the importance of handling and movement is recognised, whether inspired by the vast tonnages to be moved, from

economic reasons, or the necessity for speed of movement, a technique and practice has been evolved by the engineers within those industries, to which the manufacturers of plant and equipment have made a singular contribution by designing ahead of requirements. The many fine examples up and down the country testify to our inventive skill and ability to apply these developments with success. The general pattern may be the same, with variations from industry to industry, to meet particular requirements. One would have expected that modern methods would have become universal by 1956. It is difficult to understand how the attitude of: 'We make a profit, so why worry?' can still persist; markets can both rise and fall.

In conclusion, the suggestion is put forward that executives, technical staff, foremen and operators should be encouraged to become conscious of and as interested in the movement of what they make as they are in the making. One notices this awareness in some organisations where there is a desire for improvements in methods of handling. Nothing can remain static for long; the subject under reference is no exception.

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Germany's New Petrochemical Works

FOLLOWING the spectacular development of the petrochemical industry in the United States during and since the war, four European countries—France, Italy, Holland and Great Britain—have taken up the manufacture of petroleum chemicals on a large scale. They are now joined by Western Germany. A £6-million plant, the main product of which is polythene, has been built at Wesseling in the Rhine province between Bonn and Cologne by the Rheinische Olefinwerke GmbH., a firm founded in August 1953 and jointly owned by Deutsche Shell A.G., Hamburg, a member of the Shell combine, and Badische Anilin- und Soda-Fabrik, Ludwigshafen/Rhein, one of the former I. G. Farben firms.

The plant, which is the first of its kind in Germany, is situated on a 90-acre site, allowing plenty of room for expansion. The raw material consists of gases which are piped from an adjoining petroleum refinery belonging to the Shell group. These gases, formerly regarded as a waste product of the refinery, contain highly reactive olefine hydrocarbons.

Manufacture of pure ethylene

The incoming gases are subjected to a pressure of 30 atm. and cooled to −30°C. The pressure is then released in stages; the gases are partially liquefied and separated by fractional distillation. Ethane and ethylene of fairly high purity are obtained. In order to increase the ethylene output, the ethane is subjected to thermal decomposition in a cracking plant. The cracked gases, which are rich in ethylene due to the main reaction

$$CH_3.CH_3 = CH_2{:}\,CH_2 + H_2,$$

are cooled, purified, compressed and mixed with the refinery gases entering the gas separation plant, so that practically all C_2 hydrocarbons are obtained in the form of ethylene. There is a possibility of subjecting also the propane fraction to the cracking process, which would increase the ethylene output still further according to the equation

$$CH_3.CH_2.CH_3 = CH_2{:}\,CH_2 + CH_4,$$

but this is not yet being done.

Polythene manufacture

Whilst methods for isolating ethylene from gas mixtures have been known for over 25 years, industrial methods of polymerising ethylene have only been discovered during the last decade. In developing such a process the Badische Anilin- und Soda-Fabrik had the advantage of being able to use the experience in high-pressure synthesis gained when putting the Haber process for the manufacture of ammonia into operation. The pure ethylene is mixed with oxygen, which acts as a catalyst, and subjected to a pressure of over 1,000 atm. and a temperature of 200°C. The polythene formed is separated from the residual gases, cooled, granulated and sold under the trade name of *Lupolen* (short for Ludwigshafen polythene).

The product is a colourless solid reminiscent of paraffin wax, but considerably tougher. Thin foils are transparent, thicker layers translucent, but for many purposes coloured varieties are required. Tubes, for example, are often preferred in black, because they are then more resistant to strong light. A plant for colouring polythene has therefore been added to the polymerisation plant.

Only part of the ethylene obtained from the gas separation plant is polymerised, the rest being converted into ethylbenzene ($C_6H_5.C_2H_5$), which is sent to Ludwigshafen for further conversion into styrene (phenyl ethylene) and styrene resins (polystyrenes).

Instrumentation and services

An accurate control of temperature, pressure, rates of flow, liquid levels and so on is essential. The degree of instrumentation is therefore very high, and the processes are virtually automatic.

Water is produced by an artesian well and specially treated to protect the water pipes against attack by free carbonic acid. The boiler house contains two boilers working at 60 atm. and producing each 20 ton/hr. of steam. They are heated by means of brown coal.

Electricity is obtained from the Rheinisch-Westfaelische Elektrizitaetswerk A.G. at 25,000 volts and transformed in the works. A substantial part of the electrical energy which reaches the works is used at 6,000 v.

Effluent disposal

The proper disposal of the waste liquors is a difficult problem. With the use of water and steam in every process it is virtually impossible to prevent mixtures of oil and water entering the sewers. To simplify the separation problem, a separate drainage system is provided for the large volume of cooling water issuing from condensers, where there is little risk of oil pollution. The 'yard' drainage is carefully freed from oil and sediment before it is discharged into the Rhine.

The plant has been described in detail by Dr. Otto Roser in *Erdöl und Kohle* for January 1956. Production started last September, and the output will amount to 10,000 tons of polythene p.a. This is sufficient to cover West Germany's requirements of this important plastic and will leave a certain surplus for export. In addition, 12,000 tons of ethyl benzene will be available annually.

MIXING

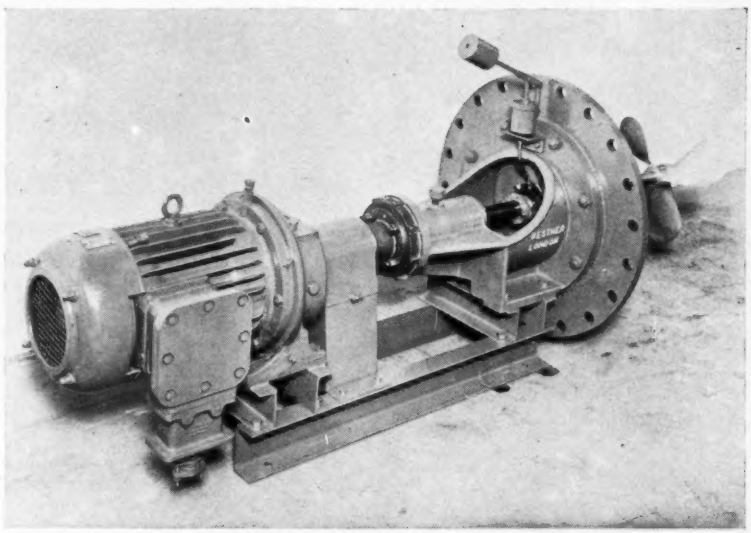
Heat transfer investigations; gas absorption and mass transfer; agitator design; dry blending; mixing of particulate solids; intensive mixing of solids

By D. F. Riley, B.SC., A.C.G.I.

SINCE the last review* on mixing appeared in this series the published literature has included papers on a wide range of aspects of the subject. In the field of liquid mixing, research is now being directed more to understanding the relations between process requirements, physical properties of the components and the flow characteristics of the impeller and vessel layout. Such an understanding will eventually enable agitated vessels to be designed to give a predictable rate of heat or mass transfer in a given chemical system, and enable design to be based confidently on the results of pilot-scale experiments.

The very limited published data on the velocity and volume of discharge from the principal types of impeller is augmented by one of the papers here reviewed. Others deal with the effect of agitation on heat transfer in coil-heated vessels, gas absorption, mass transfer in the solution of solids, and interfacial area in two-phase systems.

In the field of solid mixing three papers are reviewed, two of which present experimental data which are analysed statistically in order to develop some scientific criteria for determining the degree of mixing of solid particles.



The side-entry-type stirrer illustrated above is a development of the conventional unit and has been employed for the agitation of fluids contained particularly in deep tanks or vessels under pressure or vacuum.
A special bearing assembly is employed which allows the propeller shaft to be moved forward by hand whilst not rotating and locked in position to form a seal which prevents the escape of fluid held in the mixing vessel. This feature allows the stuffing box to be repacked without the need for draining the mixing vessel of its contents. An extra deep stuffing box is provided with grease feed to lantern rings and also a flushing connection.
Quantities of up to 20,000 gal. or more may be handled with these units depending upon the viscosity of the fluid which is to be agitated and the degree of agitation required. Kestner Evaporator & Engineering Co. Ltd. are the makers.

Heat transfer

In a paper by Oldshue and Gretton[1] heat-transfer coefficients are reported for helical coils in a vessel agitated by flat-bladed turbines under fully baffled conditions. A flat-bottomed cylindrical tank of 48-in. diam. and 56-in. high was used, having four 4-in.-wide vertical baffles arranged so that they could be located in any of three positions. Oil and water were separately used as the liquid, in order to obtain a wide range of viscosities (0.40 to 400 centipoises) and Reynolds numbers (400 to 1.5 10^6). The impellers were six-bladed flat turbines of 12 in. to 28 in. diam. and the coil was made in a single bank from $\frac{7}{8}$-in.-diam. copper or $1\frac{3}{4}$-in.-diam. stainless-steel tube. Thermocouples were embedded in the tube wall so that the temperature difference across the liquid film could be measured and the film coefficients calculated. The general correlation obtained was

$$Nu = 0.17\ Re^{0.67}\ Pr^{0.37}\ r_c^{0.5}\ r_i^{0.1}$$

where Nu = Nusselt number, Re = Reynolds number, Pr = Prandtl number, r_c = ratio of coil to vessel diameter and r_i = ratio of impeller to vessel diameter.

Two tube spacings were used, namely twice and four times the tube diameter, and it was found that the wider spacing gave a lower coefficient than the close spacing when oil of 50-cp. viscosity was being agitated. Very little difference in the heat-transfer coefficient was obtained when the baffles were placed at the wall of the tank, 1 in. away from the wall, or inside the coil, although the power consumption fell slightly the further the baffles were placed from the wall.

The effect of the ratio of impeller to tank diameter at a constant power input was measured in both water and oil, from which it was concluded that the larger the impeller the higher the heat-transfer coefficient, thus showing the importance of volume circulation in heat-transfer applications. It is pointed out that comparison of heat-

* CHEMICAL & PROCESS ENGINEERING, 1954, **35** (11), 343.

transfer data in agitated systems should be made on a basis of equal power input. On this basis it is calculated that the overall coefficient to be expected from vertical tubes, used as combined baffles and heat-transfer surface, is very little different from that obtainable from helical coils. As a first approximation it is suggested that the heat-transfer coefficient in a jacketed tank may be assumed to be about two-thirds of that expected from a helical coil at the same power input.

In order to obtain steady-state conditions, double coils were used in some of the experiments, having alternate turns arranged for heating and cooling. No difference, however, was detected in the heat-transfer coefficients between steady-state and unsteady-state conditions.

Gas absorption and mass transfer

The absorption of pure carbon dioxide in a 10% aqueous ammonia solution in agitated vessels has been studied by Ayerst and Herbert.[2] Two vessels were used having a volume ratio of 100: 1, but since, unfortunately, they were not geometrically similar, the results obtained are not valid for scaling-up purposes. A laboratory absorber was used, 5¼-in. diam. and 8-in. high, equipped with two radial baffles welded to the inside of the cooling coils and a paddle agitator 2 3/16-in. diam. rotated at 800 to 1,200 r.p.m. The pilot-plant unit was of 20-in. diam. and 40-in. high, containing cooling coils and a 6-in.-diam. vaned disc impeller, rotated at 500 to 800 r.p.m., the gas being bubbled into the solution immediately below the agitator.

They found that, when the conversion was more than 10% complete, the rate of absorption was a linear function of the concentration of free ammonia in the bulk of the solution. Their results support the earlier conclusions of Cooper *et al.* that at the same gas velocity the volumetric absorption coefficient depends on the power input per unit volume, provided account is taken of the reduction in power consumption during gassing. The 'loading point,' or maximum superficial gas velocity above which the impeller could not disperse the gas quickly enough, was found to be about 1½ to 2 ft./min. for the paddle and 5 ft./min. for the vaned disc.

Determination of the interfacial area in two-phase systems, such as are obtained in gas absorption and the contacting of immiscible liquids, has been carried out by Vermeulen[3] and his co-workers, using a photoelectric method. Droplet size counts were made on high-speed photographs of the emulsions in order to calibrate the photoelectric measurements in terms of interfacial area per unit volume. For completely transparent systems a linear relationship was found between the extinction ratio and the interfacial area, namely

$$\frac{I_o}{I} = 1 + \beta A$$

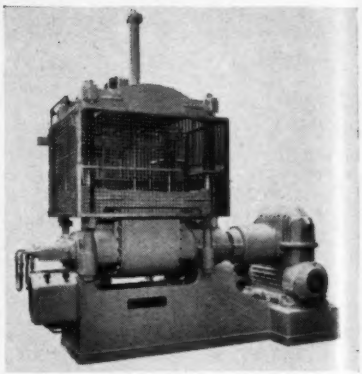
where I_o = initial light intensity, I = transmitted light intensity, β = a function of the ratio of refractive index of the disperse phase to that of the continuous phase, and A = interfacial area per unit volume.

Two cylindrical vessels were used, one being of 10-in. diam. and 10-in. high, and the other 20-in. diam. and 20-in. high, each provided with four vertical baffles at the wall and a cooling coil soldered to the outside of the tank. Four-bladed flat paddles 17.2 cm. in diam., of various widths and arranged to run at 100 to 400 r.p.m., were fitted for the bulk of the experiments. The physical properties of the liquids mixed varied over a wide range and the volume fraction of disperse phase was varied from 10 to 40% in liquid-liquid systems and from 2 to 30% in gas-liquid systems. The photoelectric probe was inserted through the top of the tank near the wall and located directly in front of a side window through which the emulsions were photographed. Mean-drop diameters were found to vary from about 0.003 to 0.10 cm. in the liquid systems and from 0.10 to 0.50 cm. in the gas absorption runs. Poor reproducibility of the results was attributed largely to the effects of trace impurities at the interface. The mean-drop diameter d decreased as the impeller speed N increased, in accordance with the equation

$$d = kN^{-n}$$

where $n = 1.2$ for liquid mixtures and 1.5 for gas-liquid mixtures, and k is a proportionality constant.

The interfacial area per unit volume was found to increase with increasing volume fraction of the disperse phase, but the effect was partially offset by increased particle size. Liquid density and viscosity were shown to have little or no effect on the mean drop size, but smaller drops were obtained as the interfacial tension σ was lowered, d being proportional to $\sigma^{0.6}$. The data were investigated using dimensional analysis, and very approximate correlations were obtained in terms of

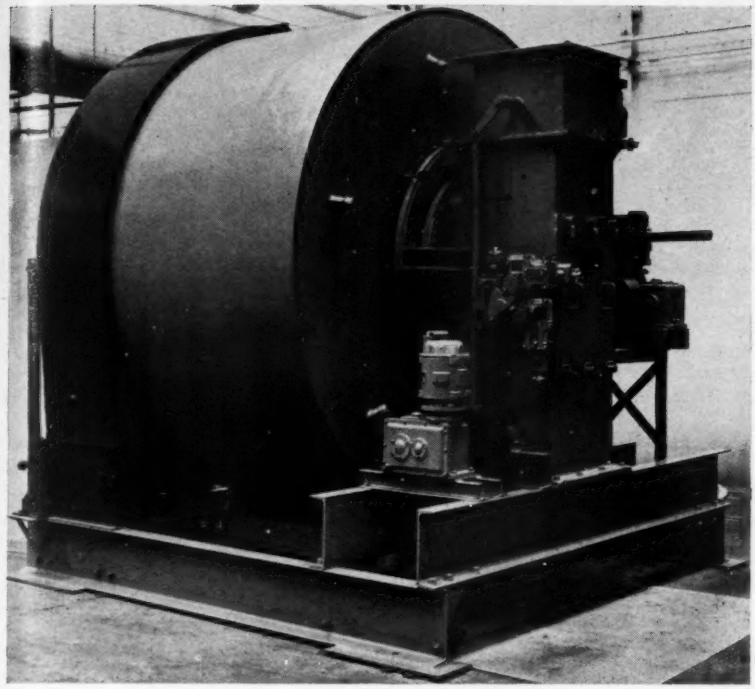


A heavy-duty mixer which has an effective trough capacity of 9 Imperial gallons and is provided with a 40-h.p. drive. It is used for processing a variety of plastics materials, including polyisobutylene and P.V.C., as well as natural and synthetic rubbers and pigment dispersions.

The mixing trough and ram are fully jacketed and the two horizontally disposed mixing blades are also cored for temperature control. The blade design is varied according to the nature of the material to be processed. For rubber and plastics work the normal selection is the three-wing Masticator blade, although the single sweep dispersion blade and also the commonly known Sigma or "Z" type blade can be fitted. Spring-loaded carbon glands are provided for sealing the trough at the points where the blade journals pass through the end walls; rotating carbon to metal seals are also fitted for the feed and return of the heating or cooling medium to the blades. In cases where operating temperatures are likely to exceed 300° F., provision is made for the oil cooling of the double row self-aligning roller bearings in which the blade axles are carried. Drive to the blades is concentrated on one side of the trough, through double helical gearing running in an oil bath. The primary drive is from a 40-h.p. motor through a hydraulic traction coupling to a worm reducer flexibly connected to the front blade shaft.

The mixing trough is tilted for discharge by means of a hydraulic ram, the tilting motion being readily controlled from the front of the machine through a simple hydraulic valve. Interlocks are provided to prevent the trough being tilted unless the compression ram is fully raised and also to prevent the ram being lowered unless the trough is in the working position. This trough tilting feature has been found especially desirable in those cases in which varying formulations are handled, as it is possible to thoroughly clean the contact surfaces between each batch. Partial dilution of master batches is often possible, and in such cases complete and speedy discharge is an obvious advantage.

The machine, supplied by Baker Perkins Ltd., has a rating of approximately 4 h.p. per gallon of material worked.



The batch blender illustrated incorporates several novel points. Largest of the standard range of Sturtevant Engineering Co. Ltd., the machine was built to handle 100 cu. ft. batches of a finely powdered material and to achieve a homogeneous amalgamation of the batch in 5 min. The most evident of the new features is the compact motorising of both the top hopper valve and the charging valve, so that complete operation of the machine can be locked into a timed sequence with the remainder of the plant. The movement on the valves is, of course, limited by switches and the possibility of failure in these switches, and consequent damage of mechanism by over-travel, is obviated by the use of slipping drives. The next most noticeable addition is in the new sampling arrangements. These comprise several capped pipes arranged in the front face of the drum. When a sample is required the machine is stopped and the cap removed from the pipe most deeply submerged in the material. The sample is then extracted by means of a special worm device.

Another major modification, which cannot be so clearly seen, is that the rear of the machine is mounted on adjustable rollers, leaving the whole back face of the drum clear for fitment of large access doors for cleaning purposes. This point can also be used to advantage for the accommodation of pressure relief panels when dangerous materials are being mixed.

the Reynolds and Weber numbers for both liquid and gas-liquid systems. The limitations of these equations are obvious when the scatter of the points on the graphs, plotted on logarithmic co-ordinates, is studied, but nevertheless this paper marks a definite step forward in our understanding of the complicated factors involved in mass transfer in agitated two-phase fluid systems.

Hixson, Drew and Knox[4] have developed equations for mass transfer in agitated batch operations, and suggested the idea of the 'time of a transfer unit' for such operations. This is analogous to the 'height of a transfer unit' concept of Chilton and Colburn for steady-state mass transfer. Previously published data of Hixson and co-workers on the dissolution of naphthalene in ethanol, the solution of salt in water, and of Mack and Marriner on the solution of benzoic acid in dilute caustic soda were analysed. It was found that the T.T.U. multiplied by a suitable velocity term gave an 'agitation number' which was reasonably constant independently of agitator speed.

Functional design of agitators

In an article on recent developments in agitation, Rushton[5] discusses the relative importance of mass flow and turbulence in various operations. In designing an agitated vessel, the size and speed of the impeller for a given power input can be chosen to give the required ratio of mass flow to turbulence. Thus large-diameter low-speed impellers give a high value of this ratio, while a low value is obtained from small-diameter high-speed impellers. Blending operations, for example, require the optimum ratio of impeller to tank diameter to be higher than it is for operations involving the dispersion of one phase in another.

Rushton emphasises the importance of the proper positioning of the impeller in the vessel and its distance from the tank bottom, tank walls and liquid surface, since this can radically affect the flow pattern obtained. In continuous plant, where the inflow is directed to the suction of the impeller, the size and speed of impeller can be chosen so as to give any desired relation between its discharge capacity and the rate of throughput of the plant. Further, its speed can be adjusted, within limits, to take accounts of variations in throughput.

Further data on the velocity of discharge from turbine-type impellers have been published in a paper by Sachs and Rushton.[6] A cylindrical glass tank of $11\frac{1}{2}$-in. diam. and 16-in. high with four 1-in.-wide longitudinal wall baffles was used, and the impeller was a 4-in.-diam. turbine having four flat blades. A shaft of light $\frac{3}{16}$-in. thick was used to illuminate any required section of the tank. Drops of an immiscible liquid were added to water in the tank and the lengths of the streaks on the photographic image were measured, from which the drop velocities could be calculated. By illuminating various planes within the blade width, data were obtained on the radial, tangential and vertical components of velocity.

The radial volumetric flow was found to be directly proportional to the turbine speed at all the radial distances covered by the experiments. The maximum volumetric flow occurred at a radius of about 4 in. at all speeds, and the difference between it and the flow at the periphery of the impeller gave the amount of induced flow. It was found that the entrained flow was approximately equal to the discharge at the periphery, independently of the agitator speed. The results for the peripheral capacity obtained agreed well with those measured earlier, by a different method, by Rushton *et al.* for a 6-in.-diam., four-bladed turbine.

An adaptation of the turbine impeller known as the *Turbo-Lifter* is described by Lyons.[7] This was developed for use as a high-capacity, low-head pump in water-treatment plant, but has since been used in counter-current multistage extractions, forced-circulation evaporators and

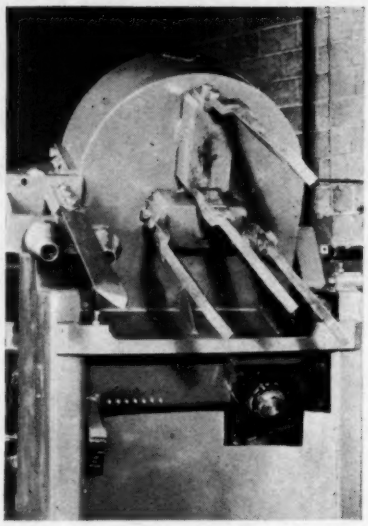
heat-exchange systems. The bottom of a turbine impeller is closed off by a horizontal plate to the underside of which are welded additional blades of appropriate dimensions to give the necessary head. These blades rotate at close clearance in a throat plate which acts as the other half of a pump casing and on which is mounted a stator ring in order to eliminate swirl.

In a general survey of turbine agitators, Lyons and Parker[8] discuss the effect of process requirements on vessel shape and the application of the various standard designs of turbine impeller. They present a chart summarising the principal factors involved in the selection of agitators for different processes, such as tank diameter and depth, and impeller diameter to tank diameter ratio.

Mixing of solid particles

Adams and Baker,[9] in a recent paper, have described a method which may be used for assessing the relative efficiency of different designs of dry blending equipment. The method was developed during tests made on the blending of polythene with a small amount of a 'master batch' containing polythene and a high proportion of additives such as pigments and anti-oxidants. The natural polythene consisted of approximately 4-mm. cubes, while the master batch was composed of 3-mm. cubes, the specific gravities being 0.92 and 1.2, respectively. In the experiments, carbon black was used as the additive so that the 'master batch' granules could easily be counted. Master batch was added to the natural polythene in the required proportions and the blender rotated for a specified number of turns. Samples of 50 g. were removed at regular intervals and the number of coloured granules counted. From 20 to 30 samples were taken in each experiment and the number of black particles plotted against the sequence of samples. The number of results lying outside certain limits were then compared with the number to be expected from probability theory.

Four types of blender were tested, namely the double cone, the ribbon, the twin shell and the rotating cube blender. The double-cone blender, while very efficient for mixing materials of nearly the same density, was found to be not so effective when handling materials of different density. In such cases the heavier constituent tends to collect in the centre of the material and to be discharged first. This tendency to segregation is attributed to the repetition of symmetrical movement which is part of the action of this type of mixer. It is affected by density difference, particle size and surface finish, and may be reduced by fitting internal deflectors or rotating paddles. Poor results were obtained from two kinds of ribbon blender, due mainly to the absence of efficient mixing action along the length of the trough. Rather better results were obtained from a twin-shell blender, but the best results, for this particular mixture, were given by a cubical blender containing an internal paddle arm.



A faster, more thorough mixing action, through a double-action motion, is claimed for a double paddle mixer now available in America in two models: the vertical-raising-head type in sizes of 8, 15 and 40 gal.; and the tilting-head type in sizes of 80, 100 and 125 gal.

The new unit is equipped with a special scraper positioning device. As the container rotates on the mixer platform, the device rides along the edge of the can. According to the manufacturers it guides the scraper blade so that even out-of-round vessels are scraped clean. In addition, it is stated, the new patented "floating scraper" stirs the material into the three mixing orbits, but "floats" at a constant pressure to clean the side without scraping metal particles into the mix.

The three mixing orbits are created by four blades mounted on two shafts, and the blades extend to the bottom of the container. This is designed to force material at the bottom up into the mix. One mixing orbit is created by the motion of the vessel. Two more are created by the two shafts, each driving two blades. As material is mixed it is forced through these blades and orbits for fast mixing.

Suppliers are the Cincinatti Hildebrand Co. Inc.

The mixing of particulate solids has been the subject of experimental and theoretical study reported in a paper by Weidenbaum and Bonilla.[10] Ottawa sand was mixed with salt crystals in a horizontal cylindrical drum $5\frac{3}{4}$-in. diam. and $8\frac{1}{4}$-in. long rotated at 45 r.p.m. The components were loaded at opposite ends of the mixer, the drum rotated for a certain number of turns and samples then withdrawn for particle counts under polarised light. The particle sizes were in the range 40 to 50 mesh, the bulk density of the sand was 1.54 and of the salt 1.16, the salt having a slightly higher angle of repose than the sand. The experimentally determined particle distributions were then compared with those calculated for a randomly mixed batch. Curves were plotted of the standard deviation against the number of turns, showing that a segregation effect was at work, due to the poor longitudinal mixing in a simple drum blender.

A higher sand concentration was found at the centre of the drum than near the ends, this axial concentration gradient depending on differences in particle density, angle of repose and surface curvature near the ends of the drum. The curve for one run showed a steady fall in the standard deviation to a figure approaching the theoretical value for random distribution at about 1,600 rev. and again at 8,000 rev. Between 1,600 and 8,000 rev., however, and between 8,000 and 24,000 rev., the segregating effect was clearly reflected in a rise in the value of the standard deviation. The authors propose a statistical criterion in terms of which the 'degree of mixing' may be described. The criterion used is the ratio of the theoretical standard deviation, calculated for a random distribution, to the experimental value determined by analysis of samples, and has the advantage that it approaches unity as the particle distribution approaches the random condition.

Intensive mixing in muller-type mixers is discussed in a paper by Bullock.[11] By intensive mixing of solids, as opposed to volumetric mixing, is meant the combined action of frictional rubbing and blending with a limited amount of grinding which is necessary for mixing aggregates such as are met with in the foundry, ceramic and refractory industries. The muller wheels are made from steel tyres shrunk on to cast-iron centres and rotate in a stationary, flat-bottomed, shallow, cylindrical pan. They are pivoted from a crosshead so that they

(*Concluded on page* 162)

COAL
—Raw Material for Chemical Synthesis

By A. R. Myhill, F.R.I.C., M.INST.GAS.E., M.INST.F.

The abundance of coal in Great Britain has led, in the past, to its use in a very wasteful manner. This is now becoming more and more realised in view of the competition of petroleum products, and the possibilities of atomic power in the comparatively near future. The present article considers the re-orientation of the coal industry with the object of exploiting its potentialities as a source of refined fuels and chemical products.

IN considering the past, present, and future use of coal, we in Britain often find it difficult to look at the subject objectively, since we have grown up in a historical tradition of industrial supremacy based very largely on our internal wealth of coal. Other nations, not so well favoured in this respect, have been compelled, in self defence, to make use of increasingly large quantities of other sources of heat and power, and/or to use their own and their imported coal to much higher degrees of thermal efficiency than that obtained, on the average, in this country.

Examples of wasteful usage of our national heritage are to be found in the burning of bituminous coal in open domestic grates, locomotives and power station boilers. In contrast to this, we have the highly thermally efficient use of certain types of coal in the gas and coking industries.

Notwithstanding the growing awakening of industrialists to the need for conserving our fuel resources, it is still a fact that by far the greater proportion of our coal is used in a regrettably wasteful manner. While this is a state of affairs reflecting some measure of discredit upon us, it has not been easy to avoid it. A few generations ago, coal in this country was, by our present standards, cheap and easy to obtain in the types and qualities needed for our use. Its application to industrial and domestic purposes in appliances and by methods in which economy was a secondary consideration was resorted to as the line of least resistance. For the time being, our needs seemed satisfied. Conditions, however, have drastically altered in the past decade, and will alter even more so in the near future. Our national economy is based on industrial production and use of power, and we have no appreciable indigenous sources of power except coal. We must, in the first place, mine our coal at the fastest rate of production, and it is the production of the last few million tons p.a. which is costing the National Coal Board so much money. Any method of avoiding waste of coal in use or, for that matter, of providing energy apart from coal at an economic price will, by relieving the coal-mining industry of the necessity of urgency in obtaining this marginal amount, lead to lower costs of manufacturing operations.

Coal as a raw material

So far, we have considered coal as a source only of heat and power. As a fuel, it can be used with various degrees of efficiency, depending mainly on two factors, *viz.* the appliance in which it is burned and the pre-treatment, if any, to which the coal has been subjected.

Coal, however, is not merely a fuel. It is a valuable potential raw material for the manufacture and recovery of chemical products. The likelihood that coal might prove a source of chemical production has been recognised for many years, but practical development of these potentialities has been hampered in great measure by our lack of fundamental knowledge concerning the chemistry of the coal substance. It has been known for a long time that coal contains a very large number of organic substances, but the complexity of these is very great—much more difficult to study than, for example, the constituents of petroleum, which is composed almost entirely of hydrocarbons the chemical nature of which is well understood. In addition to hydrogen and carbon, coal contains organic compounds of nitrogen, sulphur and oxygen, and the structure of molecules containing these elements is still largely speculative. It is only about 20 years ago, for instance, that the serious study of the cellulosic and lignitic constituents of coal was commenced, and investigations on these substances are still in progress.

A great deal of information has been collected on the subject of coal chemistry, based on the extraction of coal with solvents, chemical treatment with acids, alkalis and other reagents, notably oxidation by alkaline permanganate solutions, experiments on the pyrolysis of particular fractions, and many physico-chemical determinations.

Much difficulty exists, however, in interpreting the findings of such work and in relating the knowledge to practical applications. There is no doubt, nevertheless, that much of it will form the basis of an important section of the chemical industry of the future.[1]

The manufacture of chemical products from coal in this country at present involves, in practically all cases, preliminary carbonisation. Carbonisation is carried out, primarily, for one of two purposes: the production of gas or the production of coke. In the former case gas is the main product, although on a weight basis considerably less than the coke which is formed as a by-product, while in the latter case, as at coke ovens and smokeless solid fuel works, the coke is the main product and gas a by-product. In both cases, however, considerable quantities of tar are produced. It is this tar which is the basis of most of the coal chemicals now made in this country. It is possible, however, under favourable conditions, to manufacture practically any organic chemical product from coal without necessarily using tar as a basic material. In the carbonising process the gas contains substances which can be used as precursors of organic chemicals. Moreover, by means of the Fischer-Tropsch and similar processes, coal, or even coke, can be used directly for organic

synthesis. Such methods will undoubtedly play a large part in the future of the British chemical industry.

'Refined' and processed fuels obtained from coal by carbonisation

Wastage in the use of coal as a fuel has already been mentioned. Such waste may be of two kinds: it may be brought about by thermal inefficiency of appliances or methods, or it may be due to the loss of useful products such as oils, tar or ammonia which are consumed or driven off in the process of combustion. Losses of this nature always occur when raw coal is burned directly on grates, either domestic or industrial. On this account, the production and utilisation of 'refined' or processed fuels made from coal is advocated as the ideal method in cases where the sole object of coal usage is the generation of heat. Such a policy not only conserves useful substances, but avoids the large unnecessary expenditure attendant upon the presence of smoke, soot and other objectionable matter formed by the partial combustion of the very substances which we ought to conserve.

Refined and processed solid fuels may be either solid, liquid or gaseous. Solid fuels of this type are, of course, the cokes or chars left behind after the carbonisation of coal, and can only normally be prepared from coals of the caking type, or from special blends containing suitable proportions of such coals. Liquid fuels include certain grades of tar oils and pitches (the latter being liquid at the working temperature) as well as the lower-boiling distillates such as benzole and naphtha, obtainable from either the tar or the gas. Gaseous fuels include coal gas, water gas and producer gas.

The terms 'soft' and 'hard' are applied—sometimes rather loosely—to the solid processed fuels or cokes. It is generally accepted that the hard cokes are those obtained by high-temperature carbonisation, and soft cokes by the so-called low-temperature carbonisation processes. This designation will be used in the present article. (Sometimes gasworks coke, being generally softer than coke-oven coke, is referred to as 'soft' coke and the latter as 'hard' coke.)

The high-temperature cokes are produced under conditions in which more or less graphitisation of the carbon takes place, yielding a material which is made up of very hard particles. Although the particle hardness of these cokes is not markedly different in the case of cokes made in different types of plant, their respective porosities, which determine the reactivity and ease of combustion, vary considerably. In like manner, the mechanical strength, which is higher as the porosity decreases, will also differ. These properties, while varying somewhat with the type of coal, are influenced mainly by the conditions under which it is heated. Where a highly swelling coal is carbonised in a chamber under pressure of its own swelling, a hard, strong coke is produced. Such a coke is eminently suitable for blast-furnace use and is the type produced in coke ovens.

Static vertical gas retort coke and, to a lesser degree, horizontal retort coke are also mechanically strong, although not so much so as oven coke. With the continuous vertical retort, however, entirely different carbonising conditions prevail, since the nature of the process and the design of the retort favour the free swelling of the coal. The coke produced is much more porous than the other high-temperature types and, for this reason, is greatly preferred for domestic open fires where its comparatively easy ignition and ready combustibility make it an ideal fuel for the purpose.

The volatile content of high-temperature coke, consisting largely of hydrogen, is of the order of 1 or 2%.

'Soft' coke, made by the low-temperature carbonisation processes, is typified by *Coalite* and similar fuels. Such material is markedly softer in its particles, and is considerably less mechanically strong than the high-temperature cokes. It is, however, sufficiently strong to withstand the necessary handling experienced in transport.

As a fuel for open grates it is ideal, being smokeless, readily ignitable and free-burning on account of its porosity and its much higher volatile matter than ordinary coke.

Each kind of coke has its own special properties which make it suitable for particular purposes, and may be manufactured either as a by-product or as a main product. The relative importance of main and by-products of any carbonising system will determine the economics of the process and the distribution of its products.

Chemicals obtainable from coal

Carbon compounds comprise by far the greatest proportion of the coal chemicals. In addition, certain inorganic substances are obtainable in limited amounts, often not in sufficient quantities or in a sufficiently high state of purity to make their extraction a paying proposition.

These include ammonia and sulphur from crude coal gas, and ash products from combustion or gasification processes which, under some circumstances, may be used as bases for the manufacture of abrasives, pigments and building materials. In addition, flue dust from furnaces consuming coal or coke may contain products which might pay for recovery as, for example, germanium, in the case of certain coals, for use in electronic apparatus. Waste gaseous combustion products may contain sulphur which is recoverable in the form of free sulphur, sulphates or sulphuric acid.

It is the organic compounds, however, which are likely to form the basis of the new coal chemical industry. These may be prepared from coal tar or coal gas, or direct from coal without carbonisation. The particular compounds likely to be made will depend greatly on the demand for such substances. There should be no inherent difficulty in preparing any organic chemical from coal if the demand for it is sufficiently great. Whether its industrial production follows will depend largely on the amount of competition from other sources and, in this respect, petroleum is likely to be the only serious rival of coal.

While there will always be a considerable demand for bulk chemical products obtainable from coal by direct or simple operations as, for example, high- or low-temperature carbonisation, gasification, hydrogenation, etc., it is certain that chemicals required in pure, or near-pure form, will have to be prepared by synthesis.

Fischer-Tropsch process possibilities

Some of the principles of synthesis of certain substances are given below. In addition to the methods given, the possibilities of the Fischer-Tropsch process and its modifications must not be overlooked. This process embodies the synthesis of a large number of organic compounds (which may, in their turn, serve as precursors of further syntheses) by the catalytic hydrogenation of carbon monoxide. Although much interesting work has been done along these lines in the laboratory and on the pilot-plant stage, its commercial possibilities have yet to be proved. The process can be operated under many conditions of temperature, pressure and catalyst type within very wide limits for the formation of different products. The mixture of carbon monoxide and hydrogen, known as 'synthesis gas' can be produced from coal, coke or other suitable

carbonaceous fuel by any of the standard gasification methods as, for example, the water-gas process. The products, in general, are aliphatic, but the process can be operated in association with the conversion of the aliphatic compounds into aromatic, by cracking, as in the petroleum industry. Operating pressures range from atmospheric to 2,200 p.s.i., the substances formed depending on physical conditions and on the ratio of the reacting gases. The reactions are exothermic. Typical reactions leading to the formation of paraffins and olefines are given below:

$$n\mathrm{CO} + (2n + 1)\mathrm{H_2} = \underset{\text{paraffins}}{\mathrm{C}_n\mathrm{H}_{(2n+2)}} + n\mathrm{H_2O}$$

$$n\mathrm{CO} + 2n\mathrm{H_2} = \underset{\text{olefines}}{\mathrm{C}_n\mathrm{H}_{2n}} + n\mathrm{H_2O}$$

$$2n\mathrm{CO} + n\mathrm{H_2} = \underset{\text{olefines}}{\mathrm{C}_n\mathrm{H}_{2n}} + n\mathrm{CO_2}$$

The Fischer-Tropsch processes are thus of very wide application and are interesting when considering coal chemicals, since they afford means for making complex organic chemicals from *any* type of coal, or even from coke, since only 'fixed' carbon is necessary as a precursor, together with steam and oxygen.

Classification of coal chemicals

For convenience in classification, coal chemicals may be grouped roughly into:

(*a*) Precursors, or parent substances.
(*b*) Intermediates.
(*c*) Final products.

It is obvious at the outset that there are no sharply delineated frontiers between these territories. In general, we may define the precursors as substances obtained from coal in the first stages of its treatment by simple chemical and physical processes such as gasification, destructive distillation, hydrogenation, oxidation, etc. The intermediates are prepared from these, and may be made by comparatively simple chemical means of separation of certain constituents from mixtures, or by synthesis. They are used in the manufacture of the final products, which may also be prepared either by separation or by synthesis.

Coal itself may be regarded as a precursor, since it may be used for the production of intermediates and final products when submitted to processes of hydrogenation, methane synthesis or direct decomposition by chemicals or extractives. Coke is similarly a precursor and can be used to make synthesis gas for the Fischer-Tropsch and other processes.

The liquid precursors are collectively classed as tars, being produced by either low- or high-temperature carbonisation of coal, and have widely different compositions according to the prevailing carbonising conditions. High-temperature carbonisation yields tars of aromatic structure, while low-temperature tars are much richer in aliphatic constituents.

Gaseous products, whether from carbonisation or from other gas-making systems, are potential sources of chemicals, mainly aliphatic, but capable of conversion at a later stage into aromatics by thermal and catalytic cracking. Crude gases evolved during coal carbonisation also contain ammonia which, under favourable economic conditions, can be recovered for sale, and also hydrogen sulphide, which is a commercial raw material for sulphur recovery.

INTERMEDIATE COAL CHEMICALS

The following list, which is capable of very considerable extension, gives typical intermediate chemicals which can be made from coal and indicates their origin and their function in providing finished products:[8]

(I) Aliphatic hydrocarbons

Although certain liquid aliphatics are present in tars, the most promising field for the separation of these substances is coal gas.[6] Here we are at present, of course, confronted with the overwhelming competition from petroleum sources both from refinery cracker operations and as by-products from those gas-making processes which make high calorific value town's gas from oil. The large-scale extraction of aliphatics from coal gas is nevertheless likely to be a not inconsiderable industry in the future. These hydrocarbons belong to the paraffin and olefine series, the former comprising methane, ethane, propane and small proportions of the higher members, and the latter mainly ethylene and propylene. These can be extracted from the gas by refrigeration or other methods. Methane can be used as a starting point in the manufacture of 'synthesis gas,' or of pure hydrogen for hydrogenation products, by controlled oxidation by steam.

Nitration produces nitro-methane, which is of interest as an explosive, solvent and oxidising agent. Chlorination of methane is a subject worthy of investigation for the manufacture of solvents, anaesthetics and fire extinguishers, although the direct preparation of these derivatives is not, at present, carried out to any great extent from methane.

Methane, ethane and propane can be converted to ethylene, and from ethylene to acetylene by exposure to high temperatures as, for instance, in the electric arc. Ethylene and acetylene, being highly reactive on account of their respective double and treble bonds, are rapidly becoming, perhaps, the principal basic materials for industrial organic synthesis. Among the most important primary chemical derivatives of ethylene may be mentioned ethyl alcohol, ethyl chloride, ethylene oxide and various halogenated products. By controlled oxidation it can be made to yield ethylene glycol, largely used as an anti-freeze agent.

A reaction of great importance in chemical synthesis is the formation of a three-carbon-atom compound from a two-carbon-atom hydrocarbon. This is brought about in the so-called Oxo process in which ethylene is treated with hydrogen and carbon monoxide (both obtained from coal) in the presence of catalysts under pressure. The product is propionic aldehyde, convertible by oxidation into propionic acid $\mathrm{CH_3.CH_2.COOH}$.

There is no doubt, however, that the greatest commercial outlet for ethylene is the manufacture of plastics and synthetic rubber from its polymerisation products. In the presence of traces of oxygen, and under pressures of the order of 2,000 atm., ethylene polymerises to give polyethylene (polythene, alkathene) consisting of long chains of methylene radicals. The structure of the sub stance thus formed is capable of wide variations ranging from crystalline to amorphous characteristics. Many useful chemical derivatives are made from polyethylene and serve innumerable purposes, including cinema and photographic films, bottles, pipes and tubes of varying degrees of flexibility, electrical insulators and plastic constructional materials.

Here again, the oil industry, at present, leads the way. Acetylene is not formed, except perhaps in traces, by the carbonisation of coal. It can, however, be prepared indirectly from coal by the old process, patented about 60 years ago, of heating a mixture of coke and limestone in the electric furnace to make calcium carbide, from which acetylene is produced by the action of water. The process has not in the past been practised so extensively in this country as in some other countries where electric power is

cheaper. Its manufacture by the controlled pyrolysis or oxidation of methane and the lower paraffins is becoming a rival to its production by electric arc preparation. The possibilities of acetylene for chemical synthesis are enormous. By the action of heat it can be polymerised to benzene. In the presence of catalysts it may be polymerised to form vinyl acetylene CH_2: CH.C: CH, which is the basis of the rubber substitute neoprene.

Chlorination of acetylene gives rise to a very wide range of non-inflammable solvents, and these can also be used as parent substances for the manufacture of synthetic rubber-like materials.

Recent investigations have shown that acetylene may provide a fruitful source of many substances of very complex chemical constitution hitherto only obtainable from natural products. The synthesis of these substances is likely to prove of the utmost value for medicinal purposes, especially since there appears to be means of preparing products similar in constitution to, but more efficacious in use than, the natural substances.[7]

(2) Aromatic hydrocarbons

With the exception of benzene and its homologues which occur in coal gas, and which can be extracted by well-known methods of oil washing or activated carbon adsorption, the coal aromatic hydrocarbons and many of their derivatives are obtained from coal tar produced by high-temperature carbonisation processes.

These substances range from benzene to highly complex polynuclear hydrocarbons, and their boiling points vary from 80 to over 300°C. They include liquids and solids.

Benzene, toluene and xylene may be obtained by the direct fractionation of coal tar, but, by reason of their high volatility, they are obtained in much greater quantities by the scrubbing of coal gas. They may be used as fuels for internal combustion engines and form starting points for the synthesis of many compounds including phenols, nitro-compounds, amines, etc., used in the manufacture of drugs, explosives and dyes.

Naphthalene occurs in small quantities in coal gas, but rarely in amounts which justify its extraction, except in cases where it may be a nuisance in causing blockages in service pipes, etc. It occurs in coal tar in greater quantities than any other compound, being present to the extent of about 7%. Crystals of the crude hydrocarbon are deposited from the middle oil fraction, passing over between 170 and 230°C. The crystals are pressed and drained to get rid of liquid impurities, washed with caustic soda and then treated with sulphuric acid to convert the bulk of impurities into soluble sulphonic acids, and the naphthalene distilled or sublimed and pure crystals collected. The chemical industry in this country is likely to be short of naphthalene in the near future unless some conservation is exercised or unless its output is increased by chemical means, as, for example, by thermal cracking of other hydrocarbons.

It is used as an intermediate in dyestuffs manufacture, being the source of α and β naphthols, phthalic anhydride (by oxidation) and decalin and tetralin (by hydrogenation). Naphthalene forms a series of sulphonic acids which are the parent substances of the naphthols and other dyestuffs intermediates. Thionaphthalene, which is recoverable from crude naphthalene by acid washing, is used in medical preparations.

Anthracene is an important constituent of coal tar, used as a starting point in the manufacture of alizarin, which is an intermediate in the production of many dyes. It is obtained from the tar by the crystallisation of the high-boiling fractions, the crude mixture with other hydrocarbons being extracted with solvents and the residue distilled in superheated steam or recrystallised from a pyridine solution. Anthracene exists to the extent of about 1% in coal tar.

Phenanthrene, $C_{14}H_{10}$, an isomeride of anthracene, exists in tar to the extent of 3 to 4% and is extracted from crude anthracene crystals. Its commercial possibilities have not been fully exploited, but it is used in dyestuffs synthesis and in the synthesis of tannins.

There are many other high-carbon aromatics present in coal tar, such as pyrene $C_{16}H_{10}$, chrysene, $C_{18}H_{12}$, picene $C_{22}H_{14}$ and fluorene $C_{13}H_{10}$, which can be used in the preparation of dyestuffs and pharmaceutical products, but these hydrocarbons occur in relatively small proportions (usually below 1%) in the tar.

Styrene $C_6H_5.CH$: CH_2 is an interesting coal-tar hydrocarbon which has an unsaturated side chain. It is, in fact, the phenyl substitution product of ethylene, which it resembles in its chemical properties, and can therefore be used as a raw material for making synthetic rubber. It can be prepared synthetically from benzene and ethylene.

(3) Phenolic compounds

Coal tar contains a considerable number of phenolic compounds which may be extracted in several ways, including fractional distillation, crystallisation and extraction of the phenols by means of caustic alkali, followed by regeneration from the alkali 'phenates' by CO_2 or other acid substance. Recovery of phenolic bodies is also practised by washing crude ammoniacal liquor with a selective solvent.

Phenol C_6H_5OH, used largely as a disinfectant and as a dyestuffs intermediate, and also employed in association with formaldehyde as a component of plastic materials, is extracted by alkali washing from the 'carbolic fractions' of coal-tar distillation. It can also be prepared by synthesis from benzene through chlorination and sulphonation.

The phenolic substances obtainable from coal comprise a very extensive range and include monohydric, dihydric and polyhydric phenols, some with side chains and some having two or more ring formations such as the naphthols. They are used for dyestuffs making, and some of them are useful as photographic developers.

(4) Organic nitrogen compounds

The most commercially acceptable nitrogen carbon compounds are the bases and the nitro-substances.

The former occur in coal tar and the latter can readily be prepared by nitration of the aromatic hydrocarbons, as, for example, the nitration of toluene for the manufacture of explosives.

Among the basic compounds, aniline, pyridine, quinoline and isoquinoline are important parent substances in the manufacture of drugs and dyestuffs. The bases can be extracted from tar distillates by dilute acid washing and recrystallised as sulphates. Aniline is present in coal tar in very small proportions only, and is commercially prepared from benzene by nitration and reduction of the nitro-compound.

The preparation of diazonium salts from aniline is a synthetic method of very great importance on account of its usefulness in the preparation of a very wide range of dyes.

THE COAL INDUSTRY IN THE ATOMIC AGE

In a recent lecture, Dr. J. Bronowski, Director of the N.C.B. Central Research Establishment, has given an opinion on the probable effect of the application of atomic energy to power production, on the future uses of coal. In February 1955 the Government

published a ten-year programme for the building of atomic power stations.[3] These are to be, not experimental, but full-sized commercial stations. Two stations are anticipated to be at work in 1960-61 and two others in 1962-63. The total output should be between 400 and 800 Mw. by 1963. A further eight stations are suggested after these, all twelve being in full work by 1956.

The total capacity will then be approximately 1,500 to 2,000 Mw., this output being equivalent to the consumption of 5 to 6 million tons of coal p.a. ' This is not, in itself, a spectacular total. By 1965 the yearly coal needs of the Central Electricity Authority will have risen . . . by, perhaps, 25 million tons. The Authority will need new plant to burn this, not with a capacity of 2,000 Mw., but much over 10,000 Mw.'

The atomic power project for the next ten years is estimated to cost £300 million, ' but the Central Electricity Authority will be spending three or four times as much as this on the new coal- and oil-powered stations which it will also need.' The programme for the next ten years for the development of atomic energy is thus a modest one and, so far as displacing coal is concerned, would result in a reduction of only 2 to 3% of the total coal mined. The programme is, however, a rapidly rising one, and the curve of atomic power production will rise sharply after 1965. The production of greater quantities of plutonium will allow of the enrichment of atomic fuel in reactors of later types and, by 1975, Dr. Bronowski suggests that the building of new power stations may have turned altogether to atomic types, and the capacity of atomic power stations will be at least 10,000 Mw., equivalent to a coal consumption of 40 million tons p.a. Existing stations will still continue to use coal and oil to the extent of a further 60 million tons of coal equivalent. After that, the demand for coal is likely to fall and atomic stations will increase correspondingly.

In considering the trends in coal production and use over the coming 30 years it seems likely that the coal industry will have to change its function and will move from a mainly extractive industry ' to what it should become (and must become if it is to survive) in an important sense—a processing industry.'

Atomic energy is likely to relieve the coal mining industry of the urgency to extract the last 10 or 20 million tons p.a. which cost the most effort, and will free the industry of the ' historical role of coal as a poor relation tied mainly to the making of cheap power.' The great potentialities of coal as a chemical and process material will then be capable of development. There will be many steps in this development, but the first is the making of highly efficient, solid, smokeless fuels and special cokes for metallurgical purposes. Then will follow the production of fuel oils of various grades from coal and of bulk production of organic chemical products—not necessarily in a high state of chemical purity, but of the type which includes precursors of other substances and, later, the manufacture of chemicals in the pure form.

It is imperative that we face the changes which the advent of atomic energy must bring in order that we shall not be overtaken by the progress of events.

This means the abandonment of many prejudices rooted in tradition. Improvements in methods of mining, cleaning and transporting coal, design of special forms of chemical plant and decisions as to where certain operations are best carried out, whether underground, at the pit head or at more remote centralised locations, must be considered objectively, and we must not forget to look for suggestions based on practice in other and newer industries.

The new relations of coal and oil[4]

During the past decade a new industry has arisen and assumed great importance in Britain. It has been brought about by the importation of crude oil, mainly from the Middle East, and its refining at large stations in Great Britain. This has resulted in the production, and release for home consumption and export, of large quantities of petroleum products useable as fuels and chemical materials.

The amount of chemical products at present made from coal is very small compared with those made from oil. We have not yet fitted coal into the chemical industry, notwithstanding its great potentialities in this respect. When we have done this—and it must be done in the not-too-distant future —coal and oil may become rivals as chemical raw materials or, on the other hand, they may become, in a large degree, allies in the same field, because there will be some products which can be better and more cheaply prepared from oil than from coal and *vice versa*. It is not unlikely that products from one industry may be used as intermediates in the manufacture of products from the other. While this may turn out to be quite a satisfactory arrangement, we must never overlook the fact that oil is not an indigenous material in this country, and all but negligible quantities have to be imported. Under such conditions, war risks, international complications and vested interests are very serious considerations.

We have still huge coal reserves. It has been estimated that, at the rate of 250 millions tons annual extraction, there is enough coal in Great Britain to last for 600 to 700 years.[5] By comparison, the world reserve of oil is considered by some authorities to be not longer than 20 to 30 years, although this figure is doubtful, in view of the frequent occasions on which new deposits have been found. It behoves us, therefore, to spare no efforts in developing a coal-chemical industry.

The science of organic chemical synthesis has now reached a point at which, despite our lack of complete understanding of the molecular constitution of many of our naturally occurring substances, it is now possible, in the laboratory, to prepare practically any carbon compound from coal or oil.

The problems in industry are, of course, to do this economically on a scale suited to the demand for any particular product. In this connection the constituents of petroleum and of coal have certain important differences.

At the present day it is, in general, a simpler matter to make organic chemicals from oil constituents than from coal. This is partly because we have a background of a much greater concentration of research on oil chemicals and partly because the substances in coal often need a more drastic ' breaking-down ' treatment before the real synthesis can be proceeded with. For example, many coal derivatives, especially those obtained as by-products of the high-temperature carbonisation processes, are essentially aromatic or ring-molecular compounds, whereas petroleum contains a very high proportion of aliphatic or chain-molecular substances. While it is a relatively simple matter to convert the paraffins, for instance, into aromatics by well-established processes of cyclisation, it is not so easy to convert the ring molecules into aliphatics, which are very convenient substances with which to start a synthesis.[6] This suggests that, if we wish to prepare aliphatic compounds from coal, there may be at least two ' short cuts ': either to carbonise the coal at a relatively low temperature, whereby tars and oils are produced with a high aliphatic content, or to use the gaseous

carbonisation products as starting points, since these will already be in a large degree aliphatic.

The need for investigation and research

Much investigation and research work is already in progress, notably by the British Coal Utilisation Research Association, the Coal Tar Research Association, the National Coal Board and the fuel and chemical engineering departments of our universities. Much can be learned by a study of contemporary work in America and on the Continent. Much more is needed and will continue to be needed for many years to come. The plan of investigation in matters of this nature can never be drawn up successfully or completely at the outset or, indeed, at any stage, since the direction of the progress which is made will determine the needs of future researches. There are, however, a few outstanding phases which might well be given immediate attention. These include the following:

(1) Further investigations on the properties of domestic solid smokeless fuels and the design of appliances for burning it. Notwithstanding the proved advantages accruing from the use of these, there is still a great volume of prejudice against them by the non-technical householder.

(2) Investigations of unconventional methods of mining and coal handling at the mines with a view to bringing it to the surface in a form suited to new processes carried out at the colliery itself. Dr. Bronowski[2] suggests the possibility of continuous drilling and of piped conveyance in a stream of water, cleaning the coal on the way.

(3) Fundamental research on the chemistry of coal and its products and its application to large-scale processes. In particular, attention should be directed to the chemical composition of high- and low-temperature coal tars and their derivatives, principles and practical details of organic synthesis, methods of precise chemical analysis of organic substances, study of methods of separation of gases obtained by carbonisation, and production of gases by hydrogenation and methane synthesis.

(4) Investigation of new uses of coal chemicals.

In all this, we must be wary of the dangers of limiting our horizon by too closely following established tracks. Unconventional approaches should be followed up, and wide vision should go hand in hand with experience.

In attempting to find short cuts, we must be warned against the danger of being led into a slavish following of another industry without realising that there may be essential differences in conditions.

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Mixing

(*Concluded from page* 156)

ride on the material, and the grinding action is much less than in the edge runner mill from which the muller type of mixer has been developed. Screws are provided for adjusting the clearance of the muller wheels above the bottom of the pan, and springs for regulating the pressure of the wheels.

The limited grinding action is determined by the weight and clearance of the wheels, while the rubbing action derives from the fact that the muller wheels are wide faced and rotate in a short radius circle about the central turret. The volumetric blending is accomplished by wear-resistant steel ploughs which turn the material over before sweeping it into the path of the mullers. The action of the ploughs can also be used to empty the mixer through a part in the base of the pan. Mullers are commonly driven from underneath the pan by a geared motor, the vertical shaft speed being 10 to 40 r.p.m. depending on size. The mixing pan may be jacketed for heating and cooling, closed for vacuum operation or fitted with an exhaust hood to remove injurious dust. The peripheral speed of the mullers is of the order of 200 to 250 ft./min. and power consumption is moderate. Muller-type mixers are used for both dry and wet mixing, but in the latter case there are definite limits for the liquid content of the mixture, which must be neither too fluid nor too pasty.

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Smoke Alarms

During the final passage of the Clean Air Bill through the Commons a clause was inserted enabling the Government to make regulations requiring smoke-measuring instruments to be installed and used. Complex measuring equipment has been available for a number of years, but because of its relatively high cost it has often been beyond the reach of some firms.

The British Standards Institution has now issued a new standard (B.S. 2740) for simple smoke alarms and alarm metering devices which is designed particularly to help the smaller manufacturer combat air pollution and economise on fuel. By following its recommendations he can also be confident that his plant is being operated to conform with impending legislation.

The instruments covered in this standard normally consists of three fixtures to be installed on industrial chimneys: (*a*) a light source such a a lamp and projector, (*b*) a receiving unit consisting of a photocell and amplifier and (*c*) a visual or aural alarm. When the alarm bell rings or the light flashes, it will be the responsibility of the plant operator to adjust firing conditions so that smoke will be reduced.

In addition to the alarm mechanism, two kinds of simple metering device are specified which can be used to record the number of alarms given and their duration. Records from such meters could be used by manufacturers as a defence in any action brought against them under the Clean Air Bill when it becomes law.

An important point to note is that the instruments specified in the new standard will only record black or grey smoke, not white or coloured smoke; nor will they be suitable, for example, where boilers are fed with pulverised fuel.

Copies of the new standard may be obtained from the Sales Department, British Standards Institution, 2, Park Street, London, W.1, price 3s. each.

Ion Exchange in Uranium Production

STORY OF NEW PROCESS IS RELEASED

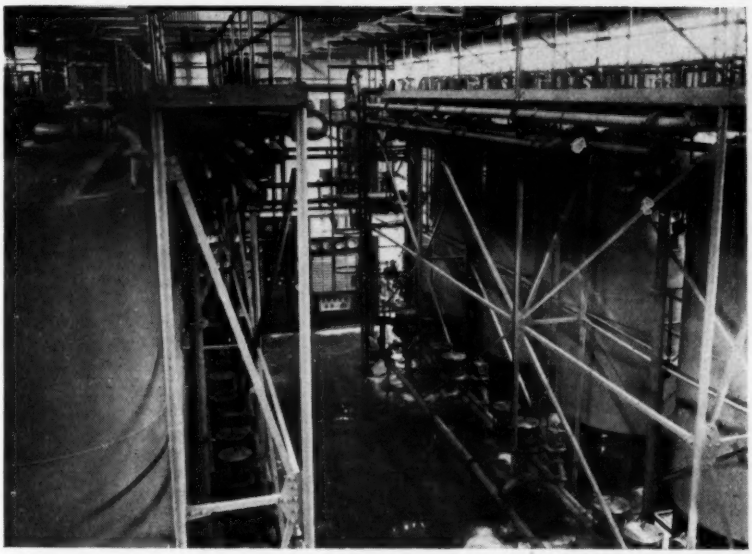
WIDELY used by industry for softening and demineralising water, ion exchange has now been adapted for extracting uranium from low-grade ore. This development in chemical process engineering has made a spectacular contribution to world production of uranium; in fact, with the partial removal of security restrictions, it can now be said that, without the use of ion exchange, Britain's plans for the peaceful use of atomic power would today be considerably less advanced.

Up till 1939, no low-grade ores were processed for uranium recovery, and even the high-uranium-content pitchblende deposits of the Belgian Congo and elsewhere were used almost entirely as sources of radium.

Following the second world war, these rich deposits—containing as much as 70% of uranium oxide—were insufficient for meeting the new and urgent uranium demands, and a world-wide search was made for other high-grade ores. This, however, was unsuccessful; though uranium is of relatively common occurrence, no more rich deposits were found, and it was therefore necessary to extract uranium from the low-grade ores.

Difficulties were soon experienced. Even the richest of these low-grade sources contain less than 0.5% of uranium or, say, ½ lb. in 1 cwt. of ore, and extraction of the uranium by classical methods proved costly, laborious and inefficient. New processes were required to upgrade these low-grade sources to give concentrates rich in uranium which would serve as raw materials for the production of uranium metal. No difficulty was found in dissolving uranium from these ores with dilute acid, but unfortunately many base metals were dissolving at the same time. The liquor thus contained a relatively low content of uranium in the presence of much larger quantities of valueless salts, and no simple and cheap method of separation was known.

For some time, little progress was made until it was discovered that, if the leach solution was passed through an anion-exchange column, the uranium was adsorbed on to the resin whilst practically all other metallic impurities passed straight through the column. This was a completely unexpected result, since metals in general are adsorbed only by cation exchange and not by anion exchange.

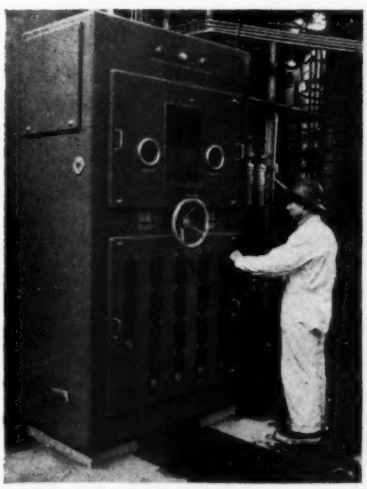


Permutit ion-exchange uranium extraction columns at Port Pirie, South Australia.

Pilot-plant experiments

The possibilities resulting from this discovery were of immense importance because—in one simple step—it was feasible to produce a concentrated and relatively pure solution from which the uranium could subsequently be removed by a simple precipitation process. Intensive research was at once put into operation both in Britain and in the United States; and when the technique involved had been carefully worked out, a pilot plant was installed in South Africa for treating the low-grade uranium ores associated with the Rand gold tailings and deposits.

The results obtained with this pilot plant were, if anything, even more successful than had been expected, and the decision was at once taken to use ion exchange for the uranium extraction process.



Hydraulic control cabinet for plant.

How the process works

Ion-exchange materials are substances of complex molecular structure having the ability to exchange or adsorb ions from solutions with which they come in contact. They are commonly used in the form of columns of granular particles through which the solution to be treated is passed; in the familiar application of water softening, cation-exchange material is used which exchanges sodium cations for the hardness-forming calcium and magnesium ions, and this softening action continues until all exchangeable sodium ions have been given up to the water. When this point is reached, the ion-exchange column is ' regenerated ' with common salt.

For uranium recovery, the process is generally similar, but a material such as *De-Acidite FF* anion-exchange

resin is used on to which the uranium from the pregnant leach liquor is adsorbed in anionic form. This adsorption continues till the resin is fully loaded with uranium; the column is then ' eluted ' with an acidified salt solution to strip the uranium, which is subsequently precipitated from the eluate. The final product consists of dry cake containing up to 90% uranium oxide.

Owing to the valuable nature of the pregnant leach liquor and to the necessity of producing pure eluate with the highest possible uranium value, the liquor is recycled, *i.e.* it is passed through two, and sometimes three, columns working in series. Also, to reduce the consumption of eluent, elution is also carried out on a recycling basis.

Though the theory of the process was clearly established and results obtained with the South African pilot plant were available, the design and construction of large-scale equipment involved was very different from that of water treatment, and there was thus little practical experience on which to base the design. Furthermore, because the solutions to be dealt with were highly corrosive, unusual constructional methods had to be adopted; this aspect was further complicated by the complex flowsheet, and by the need to provide fully automatic controls. Finally, these plants had to be constructed under conditions of strict secrecy and delivered to a programme which, under normal conditions, would have been regarded as impossible.

It is a tribute to the skill and ability of British industry that these difficulties were overcome and that the first full-scale ion-exchange uranium extraction plants were successfully commissioned in South Africa by the Permutit Co. Ltd., London, within the time specified. Since then, many more Permutit plants have been supplied both to South Africa and Australia, and others are at present under constructions for uranium projects in Canada and Northern Rhodesia.

Chemical Plant Construction Materials and Problems

JUNIOR CHEMICAL ENGINEERS' SYMPOSIUM AT BIRMINGHAM

A SYMPOSIUM and exhibition on ' Modern Techniques in Chemical Plant Construction ' was held at the University, Edgbaston, Birmingham, recently. It was organised by the Institution of Chemical Engineers, Graduates' and Students' Section, Midlands Centre, and the Graduates' Section of the Birmingham University Chemical Engineering Society. The symposium was extremely well attended and there were a number of distinguished chemical engineers present, including Mr. John A. Oriel, C.B.E., M.C., president of the Institution of Chemical Engineers, who took the chair at the afternoon session. The chairman during the morning session was Dr. B. Edgington (Boots Pure Drug Co., Nottingham). The standard of the papers was very high and a great deal of ground was covered during the one-day symposium. The papers were presented under three main headings as follows:

Some special construction materials and their use by fabricators

Titanium. Mr. R. L. Preece (Imperial Chemical Industries Ltd., Metals Division) gave a summary of the methods of manufacture of the wrought forms of titanium and the alloys now available, together with discussion of the resulting mechanical properties. The corrosion resistance in a wide range of media was reported and methods of forming, pressing, welding, brazing, etc., considered in detail. Mr. Preece pointed out that available deposits of titanium throughout the world contain many hundreds of millions of tons of the metal and there is no question of any shortage. The early problems of extraction have now been largely overcome and furnaces giving 400-lb. ingots are in regular operation; others under construction in the United Kingdom will give 800-lb. ingots. Bigger furnaces are now being designed.

Mr. Preece pointed out that it is the aircraft industry which has ' paid the piper ' in the development of titanium, and which is now calling the tune.

Dealing with the corrosion resistance of titanium, he pointed out the high resistance to attack by solutions of metallic chlorides and by hypochlorites. It is also interesting to see the effect of nitric acid in inhibiting the attack by hydrochloric acid in concentrations of up to 80% and by sulphuric acid over a range of strengths. Similarly, even 200 mg. of Cu^{++} per litre will inhibit the otherwise rapid attack of 37% hydrochloric acid. In many cases aeration completely prevents the attack by organic acids, while nitric acid alone has little effect on the metal.

Dealing with the fabrication of titanium, Mr. Preece stated that welding was perfectly practicable; with brazing there are some special points to note, and he went on to enumerate these.

In answer to a question about the cost of titanium, Mr. Preece stated that, very roughly, the figure was somewhere around £3/lb. for a 200-lb. ingot or slab. For fine tube, the price was something like £20/lb.

It was also pointed out that some of Mr. Preece's remarks seemed to indicate that the price of titanium would fall. Had he any idea through which process this would be brought about? Mr. Preece replied that any reduction in the price of titanium would come about as a result of a combination of factors. He recalled that there had been a recent price reduction of the raw material in the U.K., bringing it below the U.S. price.

It was conceivable that in, say, five to 10 years, the price might come down to, say, £1/lb. for fabricated titanium.

' Corronel B.' A paper on the corrosion - resisting and fabrication aspects of *Corronel B* was given by Mr. R. Levick and Mr. E. Warde (Henry Wiggin & Co. Ltd.). The history of the development of wrought nickel-molybdenum-iron alloys was briefly traced and mention was made that it is the ' hot-short ' characteristics of these alloys which make it difficult to produce them in wrought form.

Mr. Warde pointed out that the corrosion resistance of *Corronel B*, the wrought English version of the nickel-molybdenum-iron group, is superior to

metallic silyer when in contact with hydrochloric acid, and in consequence it is incorporated in many processes where hydrochloric acid has to be handled. In the sulphuric acid and phosphoric acid fields, extremely useful resistance to corrosion is obtained, but in all instances the presence of oxidising agents increases the corrosion rate appreciably. In consequence, *Corronel B* should never be used in contact with chamber sulphuric acid owing to the presence of minor traces of oxidising agents. Considerable resistance is also offered to attack by organic acids.

Forging of the metal can be carried out quite readily, but the working range is extremely restricted, and forging should not be carried out at temperatures above 1,200°C., owing to the tendency for incipient fusion to occur, nor should forging be continued below 1,050°C., due to a tendency for the material to 'hot-short' at lower temperatures. This also applies to hot working. For welding, either argon-arc, oxy-acetylene, or metallic-arc processes can be used, and in the case of argon-arc either a.c. or d.c. can be used. When metallic-arc welding, d.c. equipment is essential with the electrode positive.

Mr. Warde mentioned that complete softening could be obtained should the material become appreciably hardened during working by exposure to a slightly oxidising and turbulent furnace atmosphere at 1,150°C. for a period of time dependent on the thickness of the work. It is, however, imperative to carry out a post-welding heat-treatment on all welded items in the range 1,050 to 1,180°C. in order to overcome a tendency for accelerated corrosion to occur adjacent to the weld. *Corronel B* is covered by Case 1173 of the American Society of Mechanical Engineers' boiler and pressure vessel code in respect of post-welding heat-treatment. The attack on as-welded *Corronel B* was illustrated by the butt weld joining two seam-welded tubes, the longitudinal seam welds having been heat treated after welding, whilst the circumferential butt was as welded. A slide indicated that complete perforation at the butt weld had occurred in a very short period of time.

Mention was made of suitable pickle baths which could be used in addition to methods of mechanical cleaning to descale *Corronel B* after thermal operations.

Stainless steels. The third paper on materials of construction for chemical plant was read by Mr. C. B. Tupholme (Samuel Fox & Co. Ltd.), who dealt with stainless steels. He divided stainless steels into three groups:

(1) Austenitic (18% Cr, 8% Ni), which steels are non-hardenable by heat-treatment and are non-magnetic.
(2) Martensitic, the hardenable group, which are magnetic and in general have inferior corrosion resistance to the first group of steels.
(3) Straight-chromium steels, which are virtually non-hardenable by heat treatment.

It is the austenitic steels in which chemical engineers are mainly interested.

The functions of the various additions to the straight 18/8 Cr-Ni steels were discussed and the effect of the addition of titanium, niobium and molybdenum was described.

In the fabrication of stainless steels the usual methods are applicable, but, owing to their greater strength compared with mild steel, more power is required. For fine chemical plant it is usual to polish for greater ease of cleaning during service, but for heavy chemical plant polishing is not always necessary, but removal of either heat-treatment or welding scale is essential, as rusting of the scale can occur.

Methods of fabrication and precautions to be taken during fabrication and designing were discussed. Among points he raised were the following: (*a*) Avoid iron-bearing abrasives, which cause superficial staining. (*b*) Remove all scale. (*c*) Avoid abrasion by steel tools. (*d*) In welding pressure vessels seams should be staggered so as not to weaken the structure by having converging seams. (*e*) Do not line soaked wooden vessels with stainless steel, as shielding corrosion may occur.

Fabrication and testing

Welding developments. Mr. D. B. Tait (Quasi-Arc Ltd.) gave a talk on modern developments in plant fabrication methods. He said that the welding processes at present undergoing the most rapid development are those using a shield of inert gas instead of the customary fluxes. There are two main processes, that using a non-consumable tungsten electrode, typified by *Argonarc* and *Heliarc* equipment, and that using a consumable electrode. The two processes can be distinguished as T.I.G. welding and M.I.G. welding.

The inert-gas processes are now of increasing importance in the construction of chemical plant, as they are usually superior both technically and economically to other welding processes for welding aluminium and its alloys, stainless steels, copper alloys, nickel alloys and the like.

The M.I.G. equipment is not only versatile in the construction of new plant, but may well replace other welding methods in repair work. Here the high welding speeds which are a feature of the process not only reduce the cost of the repair itself, but by shortening repair times allow plant to come back on production more readily.

During the discussion it was asked if welders of lower skill could be used with consumable electrode inert-gas equipment than with tungsten-arc equipment. Mr. Tait stated that all these types of welding depended for quality on the skill of the operator and that where welds of very high quality were required, then highly skilled operators were always necessary.

Industrial radiography. A brief survey of current practice in industrial radiography was given by Mr. E. J. Grimwade (Kodak Ltd.), who emphasised that noticeable changes have taken place in the last eight years. These changes included photographic aspects, X-ray equipment and wider use of radioactive isotopes, coupled with increasing experience and a more critical approach.

Photographic techniques have changed very largely from the use of salt intensifying screens to the use of fine-grain, high-contrast films with lead intensifying screens, together with higher radiographic densities. The changes in X-ray equipment have been influenced by the demand for increased mobility and portability. Some electrical circuit efficiency might be sacrificed for this mobility, but these smaller self-contained units were, on the whole, robust and reliable.

The increased availability of radio-active isotopes meant greater scope for gamma-radiography, and seven suitable sources could be used. Limitations were imposed by the use of powerful sources, as the need for protection against harmful effects called for thicker shielding, thus leading to unwieldy source containers. Gamma-radiography offered advantages in the examination of complicated structures and castings in heavy metals, since it gave greater overall coverage of thick and thin sections.

Some indication was given of increased scope by these changing trends by the facts that since 1948, approximately, manufacturers of *x*-ray equipment offered as many as four or five different types of unit as compared to about two; seven radio-active sources were available as against two; and *x*-

ray film manufacturers now produced five types of film as against three.

Magnetic, electrical and ultrasonic testing. Mr. J. D. Hislop (Solus-Schall Ltd.) discussed first the magnetic and then the ultrasonic method of crack detection and, for comparison, gave an illustration of the two methods applied to the same job in a case where riveted boiler plates were involved.

Ultrasonics can be used for the examination of welds and is especially advantageous in cases where radiography is difficult (owing to awkwardness of location, etc.). Mr. Hislop gave an interesting and somewhat awe-inspiring example of the application of ultrasonics to testing the wear in the concrete lining of a pipeline carrying sea-water for cooling, involving the testing of a great multitude of individual points along the length of the pipe.

Finally, the methods of measuring thickness by ultrasonic and magnetic means were described and illustrated, and the special fields of application of each were discussed.

Plant manufacture and erection

Fabricating problems. Mr. F. Jukes (Thompson Bros. (Bilston) Ltd.) stressed the need for the chemical engineer to appreciate the scope and limitations of the fabricating industry. Many of the troubles experienced in chemical plant could be avoided by co-operation. He gave an example of fabrication in a long conveyor screw in which the spiral had to be welded to the main shaft. The main problem was to keep the conveyor screw straight during and after welding. This, he stated, was overcome by:

(1) Producing each half flight of the conveyor screw as an accurate pressing.
(2) Supporting each end and the centre portion of the main shaft by means of bearings during the welding and cooling periods.
(3) Having a centre shaft of hollow construction which enabled cooling water to be passed through during the welding operation.
(4) Employing a planned welding sequence which incorporated the back step procedure during the fillet welding of the screw flights to the main shaft.

The maximum misalignment in the fabricated shaft was $\frac{1}{8}$ in., and this was considered very satisfactory. There were special difficulties in welding stainless steels and different techniques were needed from those employed with mild steel.

More attention must be paid to the problems of the fabricator by both draughtsman and chemical engineer. One instance of allowing for fabrication problems was in specifying fillet welds, in which the angle should be sufficient for the welder to have room to work.

Plant erection difficulties. Mr. D. S. D. Fraser (Foster Wheeler Ltd.) presented a well-illustrated paper on the effect of layout on plant erection. He said that he thought that it would be more appropriate if the title had been 'The Effect of Plant Erection Considerations on Plant Layout,' as the main theme of his talk was the need for close co-operation between the plant layout engineer and the construction engineer in the early stages of layout work with a view to getting the plant layout engineer to provide adequate space within the unit to allow the maximum benefit to be obtained from the use of up-to-date construction equipment (such as large cranes, guyed derricks or pedestal derricks).

In addition to the requirements of space for the construction work, the aspect of the maintenance of the unit was also to be borne in mind, so that heavy lifting equipment could be brought into the plant to assist on major plant overhauls.

In these days of difficulty in obtaining deliveries of items of plant in the correct sequence for erection, it is all the more important for the layout engineer to design his plant so that access to all parts of it can be obtained without having to dismantle major pipe runs, etc., as it is sometimes necessary to leave a derrick erected in the middle of a plant until the very end of the job, due to the late delivery of possibly one vessel only.

It was also emphasised that the engineer in charge of the project should do his utmost to ensure that plant items and materials should arrive at the site in the proper sequence for erection, as by this means much unnecessary expenditure could be avoided. An instance was quoted where, due to bad organisation, foundation bolts actually arrived on one job in a foreign country long after all the vessels had been erected. It is not often possible in such situations for the site engineers to obtain the necessary materials and facilities for making up heavy foundation bolts.

Project engineers were also advised of the desirability of trying to curb a client's natural desire to see pieces of plant being put up as soon as possible in order to 'make a show,' otherwise it means that the whole site organisation is frequently on the job long before required and there are continual delays due to lack of materials. If materials cannot be scheduled to come into the job in the correct sequence for erection, it is far better to delay sending the construction force (other than the necessary storesmen to receive the materials) until at least 50 to 60% of the materials have arrived and a reasonably certain schedule of deliveries for the balance is ensured.

Mr. Fraser's talk concluded with slides showing various plants under construction, with the particular point of illustrating the amount of space required during construction for the prefabrication of heavy sections of vessels on the plant site.

To Authors

The Editor welcomes practical articles and notes on chemical engineering and related subjects with a view to publication. A preliminary letter or synopsis outlining the subject should be sent to The Editor, CHEMICAL & PROCESS ENGINEERING, Stratford House, 9 Eden Street, London, N.W.1.

'Floors'

A new journal, *Floors*, has started publication in association with the long-established *Building Materials, Components and Equipment*, one of the Leonard Hill Technical Group.

In recent years, there have been many new developments in both the construction and covering of industrial, domestic and other types of floor, and it has long been felt by architects and the building trade generally that there should be a publication devoted to giving details of these developments.

It is with this object that the new journal has been published. Incorporating the enquiry card system that has been a feature of *Building Materials*, it will include articles on the various new methods of construction, new protective and decorative treatments, and reviews of new floor finishes as they are introduced. There will also be general articles dealing with the requirements of floors which have to serve a specific purpose in various kinds of industrial and commercial buildings, and a section devoted to the latest developments in other parts of the world.

Floors is initially appearing as an insert to *Building Materials*, but it will soon be published independently.

WHAT'S NEWS about

★ Plant
★ Equipment
★ Materials
★ Processes

This illustrated report on recent developments is associated with a reader service that is operated free of charge by our Enquiry Bureau. Each item appearing in these pages has a reference number appended to it; to obtain more information, fill in the appropriate postcard attached, giving the appropriate reference number(s), and post the card (no stamp required in the United Kingdom).

Automatic air humidifying machine

A new type of air humidifying machine which is being marketed under the name of *Aerosol-Turbo* is of fully automatic Continental design, robustly constructed from non-corrosive metals. No heating element is required, and the exclusion of jets, nozzles and critical adjustments eliminates the danger of clogging and ensures trouble-free operation.

One of the main features of the machine is that aerosols, uniform in size and having a weight near to the specific gravity of air, are produced without the assistance of free or compressed air and, owing to their minute size, they are completely non-wetting, floating in the air until evaporation takes place. This most important feature of the machine, together with its radical action and the use of free air only to assist in dispersion of the aerosols, results in an overall even humidity of the shed or room. The free air at the same time is designed to prevent fly and dust interfering with the efficient working of the machine.

The humidifier may be fixed to the roof or roof-trusses in close proximity to machinery and shafting without the risk of wetting and, as no ducting is required, there is a saving in roof and floor space.

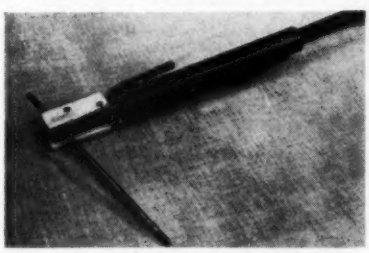
Two sizes are offered, producing a high relative humidity for rooms of approximately 21,000 and 88,000 cu. ft. Where higher relative humidity is necessary for one particular machine or corner of the shed or room, a portable model is offered which enables humidity to be directed to the point where it is required, again without risk of moisture forming on the machinery.

CPE 223

'Aerosol-Turbo' air humidifier.

Gouging and cutting

Claimed to provide a process many times faster than chipping and to be much cheaper to operate than oxygen gouging, the *Arcair* torch operates readily in restricted space and in any position, and requires no difficult adjustments for use on different materials.



'Arcair' torch.

In the *Arcair* process, cutting, grooving, gouging or developing mild steel, stainless steel, alloys, brass, bronze, monel, cast iron or any other metals are all involved. The torch melts the metal via an electric arc and then blows away the melted metal through a continuous high-velocity compressed-air jet. The arc is maintained between the work and a carbon-graphite electrode which is held in the torch, thus directing the air and controlling its flow.

The torch is a complete unit, being equipped with a concentric cable, and features an air control valve, self-

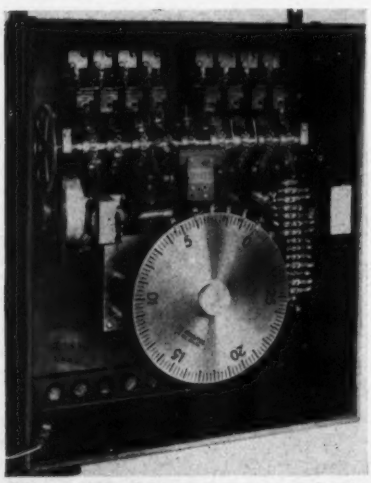
C.P.E.'S MONTHLY REPORT AND READER SERVICE

aligning rotating jet permitting adjustment of electrode to any angle, and air cooling for the comfort of the operator. It is available in two models. Model G.3 (handle 10½-in. long) is specified for light duty and uses *Arcair* carbons up to and including ⅜-in. diameter. The G.4 model (handle 15½-in. long) is specified for heavy duty and accommodates *Arcair* carbons up to and including ½-in. diameter.

The current is supplied through a d.c. welding machine. Ordinary compressed air at 80 to 100-lb. pressure is used.

The new *Arcair* method of metal removal is now being applied in foundry operations to gouge defects and to remove unwanted metal. Many times faster than chipping and much cheaper to operate than oxygen gouging, the tool operates readily in restricted space and in any position, and requires no difficult adjustments for use on different materials.

Many and varied applications of the *Arcair* process have been made in the field of maintenance—in industrial plants, on construction jobs, by the railways, and in mines and quarries. The same welding operator can also use the *Arcair* torch. No cylinders nor regulators are necessary and welding or brazing can be done without further grinding or cleaning. The torch has a wide application among fabricators using all types of ferrous and non-ferrous alloys. Depth of cut is easily regulated. The slag from welding does not deflect nor hamper cutting action and the resulting surface is clean and smooth. Fabricators of pressure vessels, steel structures, ships and armoured vehicles have found the *Arcair* torch outstanding for speed and economy. **CPE 224**



'Flexo-Timer' programme control unit.

Timed programme control

The *Flex-o-Timer* is a 'timed-programme'-type timer, consisting of two main sections: a motor-driven time measuring device and an independently driven sequence disc mechanism which controls the operation of the electric or pneumatic functions.

The timing apparatus initiates the motion of the sequence discs which move through a predetermined arc and carry self-positioning cams that latch and unlatch the functional latch operators controlling either electric or pneumatic functions. The time dial is equipped with a number of adjustable actuating clamps, each manually positioned to the exact time at which a function is to be operated. The cycle range is adjustable, and a 4-r.p.m. synchronous motor is used for all time cycles. The minimum recommended time cycle is 3 min. and the maximum provided is 4 hr.

When the timer has completed its desired cycle the time disc is reset to zero, and the reduction gears, though by-passed, will continue turning during the reset operation, thereby eliminating backlash and resultant loss of timing accuracy during the next timing cycle.

The sequence drive mechanism consists of a shaft mounted in self-aligning powdered metal bearings, on which a sequence disc is assembled for each operating function. The sequence disc is die-cast and provides 20 numbered slotted positions for mounting either the 'off' or 'on' cams. A cam mounted in a certain numbered position will actuate the latch operator at the time the corresponding clamp on the time dial indicates. The sequence shaft is driven through a gear reduction by a non-synchronous induction motor which has an average speed of 5 r.p.m., and contains a mechanical braking device which operates when the motor is de-energised.

The timing dial clamps unlatch an operator to complete the circuit to the sequence drive motor. As the sequence shaft rotates, cams mounted on it relatch the micro-switch to stop the motor. Thus the sequence mechanism shuts itself off after a pre-set rotation.

The normal rotation of the sequence shaft is 15°, but very quick sequence functions may be obtained by allowing the relatching disc to rotate by larger increments of 15°. Functions may be operated in 1-sec. time increments up to 10 sec. or more as desired.

CPE 225

MOISTURE METER

An instrument known as the Wide Range Super *has recently been produced by a British firm who claim that it works at a frequency far higher than any other commercial moisture meter, and gives a direct indication of moisture content on a dial. Its range is from complete dryness to* 100% *water and, according to the manufacturers, it is giving accurate results with many materials on which previous moisture meters would not operate.* **CPE 226**

SEAL FOR PETROLEUM STORAGE TANKS

An entirely new method of elimination of vapour losses from large petroleum storage tanks has been incorporated in two tanks each 80-ft. diameter and 36-ft. high just completed for a British petroleum refinery.

These tanks, which each hold over 1 million gal. of petroleum product, have twin-skin steel floating roofs which virtually float on the surface of the stored liquid. The seal between the twin roof and the tank walls is made by a huge 80-ft.-diameter tyre which is made of nylon fabric base, coated on each side with oil-resistant butadiene acrylonitrile synthetic rubber. This tyre is partially inflated with liquid and is secured to the floating roof of the tank and thus rides up and down according to the level of the tank's contents and thereby prevents the formation of vapour and at the same time acts as a complete seal between the floating roof and tank wall. The tyre is protected by a similar synthetic rubber scuff band and a vapour-free seal is ensured.

This new method of sealing hydrocarbon products is stated to be the first of its kind in Europe.

CPE 227

GAMMA-RAY RADIOGRAPHY

Radiographing huge pressure vessels —to detect possible flaws in vital welds —is one of the first assignments of a gamma-ray projector recently introduced in the U.S.

Shown here in use, it has been positioned on a fork-truck inside the pressure vessel, while the film to be exposed subsequently by the radioactive source is being attached to the vessel's exterior. With the shutter closed, as it is here, the shielding is so thorough that men can work close to the unit in complete safety —even photographic materials can be brought near it without fogging. In addition to being safe to operate, it is claimed that this gamma-ray device offers a high degree of penetration, is lower in cost than comparable x-ray equipment, is portable, needs no electricity or control board for operation, and can be used for the simultaneous exposure of areas over a 360° arc.

Among the industries that will have use for this new projector are manufacturers of large vessels, heat exchangers and condensers; builders of oil refineries and chemical plants; pipe fabricators; manufacturers of diesel, steam and turbine engines; foundries; and the marine, ordnance and aircraft industries.

CPE 228

Hand-operated pumps and plastic syphons

There are many instances in chemical and other industries where acids, alkalis and other corrosive liquids have to be transferred or transported in relatively small quantities. A typical example of such an operation is the emptying of carboys. For such purposes hand-operated plastic pumps are available which are claimed to be highly efficient and not attacked by most corrosive liquids. At the present time, two types of hand-operated pumps and also two types of syphon are available.

Type H.O., a small, portable, piston displacement pump, fabricated from rigid PVC, is especially suitable for emptying carboys. The pump is available with a plain outlet or with a polythene stopcock. This pump has a capacity of 15 gal./hr., taking an average pumping speed of 20 strokes/min.

For the pumping of larger quantities of corrosive liquids, and also for lifting such liquids against an appreciable head, a diaphragm pump, type H.O.D., is recommended. This pump is also entirely fabricated from corrosion-resistant plastics. The majority of the components, such as the housing and the piston, are moulded in or machined from rigid PVC, whilst the diaphragm consists of a number of very thin polythene sheets. This pump is operated by a hand lever and housed in a steel frame which permits its use right on top of a carboy. It has a capacity of 400 gal./hr., against a maximum delivery head of 30 ft., suction up to 4 ft., depending on the specific gravity of the liquid to be pumped.

The design of the *Rediweld* type H.O.D. pumps has been recently improved: a sturdier bracket is fitted; the upper part of the pump is now covered by a protective bracket; the outlet has been made detachable so that it can be replaced when necessary.

CPE 229

New phosphating process

A British firm have developed a process which, they claim, represents the greatest advance in the field of phosphating for over 20 years. According to this firm, they are the first in the world to offer an accelerated manganese phosphate solution capable of being applied by spraying. It can, moreover, be used with standard spray equipment already installed in many factories. **CPE 230**

Aluminous cement

A white calcium aluminate hydraulic cement with an alumina content of 70 to 75% and with total impurities less than 1%, is now available in Britain. Refractory concretes or castable mixes incorporating *Secar* 250 and a refractory aggregate have a normal setting time and ultra-rapid hardening properties usually associated with Ciment Fondu, but, it is claimed, they also have enhanced refractoriness.

For example, it is stated, concretes made with *Secar* 250 and corundum aggregate can be put into service at temperatures up to 1,800°C., thus increasing the range of refractory aggregates such as crushed firebrick, sillimanite, chrome and chrome-magnesite. All such concretes can be put into service within 24 hr. of casting, and it is stated that they do not shrink and have high resistance to thermal shock. **CPE 231**

Two-drum 'packaged' boiler

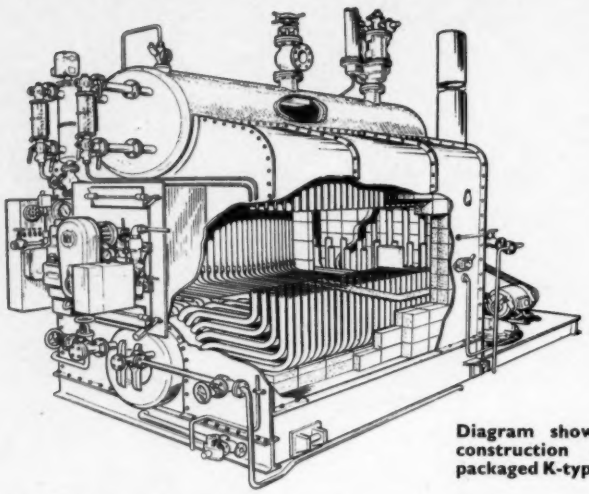


Diagram showing the construction of the packaged K-type boiler.

The packaged *K*-type boiler is a two-drum boiler and in its 'packaged' form covers a range from 2,500 lb./hr. to 17,000 lb./hr. of steam from and at 212°F., in 10 sizes. Non-packaged units are built up to an ouptut of 33,000 lb./hr. to suit specific conditions. The drums are of all-welded construction and the tubes are 2 in. outside diameter. The tubes form a continuous water wall to the furnace, the interstices between the tubes being suitably filled. Behind these furnace tubes are convection tubes of the same dimensions. The walls of the boiler are insulated with firebrick tile and block insulation and steel casing panels, which are sealed and bolted together, form an airtight casing.

In operation the heat-absorbing zones are arranged with gas flow areas proportional to decreasing gas temperature and volumes, thus providing constant flue gas velocity.

The furnace combustion chamber is completely water cooled. After leaving the combustion chamber the gases return to the front of the boiler along the upper portion of the convection tubes, suitable baffles being provided for this purpose. On reaching the front of the boiler, the gases return in contact with the lower level of the convection tubes and thence to the boiler waste-gas outlet. The course of the gases provides a very adequate scrubbing action. **CPE 232**

Reverse-jet filter for small particles

A new filter has been produced whereby the reverse jet of cleaning air is applied uniformly over the entire filter surface by means of a slotted tube ring which touches and, in fact, slightly indents the filter medium. This, according to its manufacturers, is the main feature of importance which distinguishes the *Hersey* filter from other types of so-called blow-back filters.

In its simplest form a reverse-jet filter of this type consists of one or more wool felt sleeves which are surrounded by travelling slotted rings fed by air from a blower or high-pressure centrifugal fan. The whole unit is mounted in a framework which is enclosed when operation under suction is required. The high-pressure air unit can be mounted on the framework or elsewhere as space demands, and air connection to the travelling blow ring assembly is by flexible ducting. The gear and motor are normally mounted on top of the upper manifold. In this way these components are not subjected to dusty conditions and, if conditions require it, they can be suitably protected.

The felt sleeves are hung and fixed between the upper and lower manifolds. Each sleeve is encircled by a blow ring of polished metal having a slit round the inner surface which is in contact with the felt. The contact with the felt is very important. This is achieved in the *Hersey* filter by the use of self-adjusting blow rings mounted in a travelling manifold frame. The rings are mounted as quadrants held by springs under tension in the vertical and horizontal planes. This method is said to ensure constant contact pressure under all conditions.

The blow ring assembly moves continuously up and down the sleeves during the operation of the unit and in an assembly of tubes 12 ft. long, only 0.5% of the filter area is out of service at any time, due to the cleaning action. It is also pointed out that there is no need for temporary shut-down for a section to be cleaned, with consequent variation of pressure drop, air flow and efficiency.

It is stated that the *Hersey* filter usually provides 99.9% or better collection on weight basis, this percentage being adequate for almost all industrial duties. Advantages claimed for the filter are as follows:

(1) Its efficiency is high even for dust of sizes between 1 and 0.1 micron.

(2) The output of cleaned gas is constant, since the filtration surface remains clean and the pressure drop is consequently almost invariable.

(3) Operation is continuous, as the reverse jet of cleaning air is applied during the passage of the gas to be filtered.

(4) The system is extremely adaptable in that the intensity of the jet, its frequency and the speed of movement of the rings can be regulated at will.

(5) The system is also economical, as it only requires simple, strong apparatus which takes up little space. **CPE 233**

Accurate feeding and weighing

A British firm announce that they are to manufacture the Schaffer *Poidometer*, which is described as an accurate feeder-weigher used in mining, milling, smelting, refining and concentrating industries. It handles all crushed, granulated and pulverised matter.

The *Poidometer* is used in the U.S. to weigh and feed coal to furnaces and driers and at the same time keep an accurate fuel consumption record. In mechanical plants, such materials as bauxite, phosphate rock, soda ash, soap powder materials, alum and lime can be handled and, according to the makers, improved quality is made possible by accurate proportioning by weight.

Clay products, feed, fertilisers, oil refining, metal work and water purification industries all offer numerous applications. **CPE 234**

Grinding mill

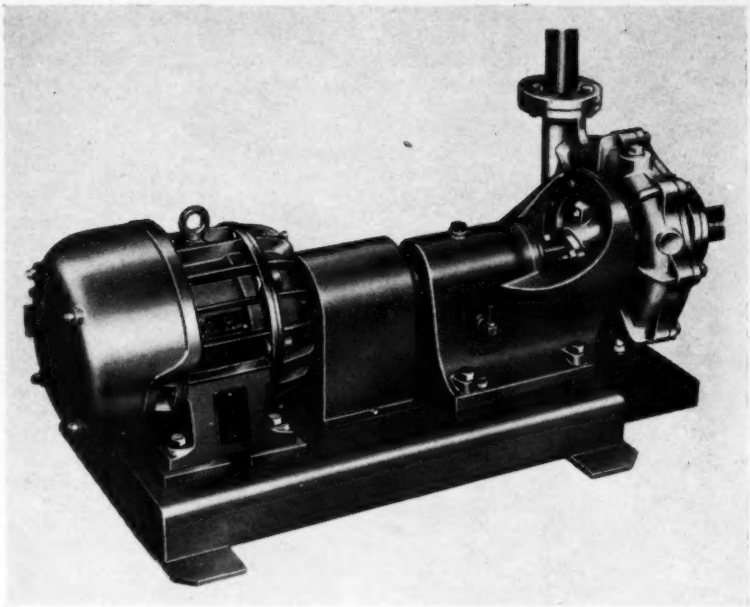
In the *Kek* pin disc-type pulveriser, which has been available for a number of years, the grinding parts consist of a horizontal disc, revolving at high speed, which contains a number of pin-like projections so arranged that they pass between similar pins on a stationary disc. The material to be treated is fed into the machine through a hole in the centre of the stationary disc. The powdered material is thrown off by centrifugal force and suitably collected.

The manufacturers of the *Kek* mill have produced a new grinding mill for the purpose of producing fine powders substantially free from admixture with larger particles. To this end, a form of air separation has been incorporated in the new machine. Unlike many other machines designed with a similar object in mind, however, the manufacturers state that the *Superkek* uses no moving parts to achieve the necessary particle size classification.

In this new mill, fan blades fitted to the underside of the rotary disc set up such an air flow that the ground material issuing between the rotary and stationary discs is carried upward through an annular space between the machine casing and an inner case which contains the hopper by which material to be ground is fed to the mill. On reaching the top of the machine casing, the ground material is deflected downwards, with the result that heavier particles pass down to the hopper whilst the fine material which remains airborne passes up an outlet pipe.

The superfine powder leaving the selector chamber is drawn into a cyclone collector, of high efficiency, by means of a fan on its exhaust side. In general, the exhaust air is then vented to atmosphere through a multi-bag filter. Alternatively, a closed-circuit grinding system may be used and, in this case, exhaust air from the product collector is conveyed by ducting to the chamber and hence reintroduced to the mill. The closed-circuit system is particularly useful when it is necessary to maintain an inert atmosphere within the machine due to the material under treatment being of a highly explosive or inflammable nature.

Advantages claimed for the *Superkek* are: (1) the initial cost is smaller; (2) all normal maintenance may be carried out by unskilled labour; and (3) operating expenses, including power consumption and maintenance, are minimised. **CPE 235**



Stainless-steel chemical pump.

Stainless-steel chemical pumps

Stainless steel today finds so many applications in the chemical, process and food industries that clearly many engineers have a definite preference for a stainless-steel pump, provided it complies with certain requirements, such as good availability, reasonable price and flexibility in use. A British firm state that they have met these requirements of the chemical and process industries in design and in performance by their development of the B-N series of stainless-steel chemical pumps.

B-N pumps are available for outputs from 5 gal./min. up to 200 gal./min. against heads from 10 to 250 ft. To cover this wide range of duties only two support frame assemblies (sizes 1a and 1) are used, but with these two support frame assemblies (comprising bearings, housing, shaft, shaft seal and stuffing box) a total of six different hydraulic units can be used. The impellers are designed so that a turned-down impeller gives, with the same casing, three or four different fields of duties and horsepower requirements.

The makers point out that, by keeping to a minimum the number of components required to cover the range, and by means of close-spigotted fits, the B-N range offers a very high degree of standardisation, with all the advantages of easy maintenance and replacement at site and small number of spares to cover pumps for many different duties.

Special attention has been given to effective sealing—a vital point in chemical process pumps. A selection of methods of sealing is available, and any of these can be utilised on the B-N pump without modification of the shaft or stuffing box. The seals used are of well-known manufacture and are readily obtainable.

The following are some typical applications for which the B-N is used: nitric, all concentrations, 70°F.; sulphuric 10%, 70°F.; oleum, 70°F.; cupric sulphate 10%, 70°F.; developers, etc. **CPE 236**

Self-priming electric pump

A new pump unit, comprising a self-priming pump mounted on the flange of a split-phase motor, operates on the well-known water ring principle where the volume enclosed by the blades of the impeller increases towards the suction inlet and decreases towards the discharge opening, which provides a continuous non-pulsating flow of liquid.

It is claimed that the construction of the pump is such that years of operation without attention can be expected. The body is made of close-grained cast iron. The working parts of the pump, namely the impeller and enclosing chamber, are both made of hot brass

stampings. A mechanical face-type seal is fitted, consisting of a *Hycar* rubber sealing bellows, a carbon running face and a phosphor bronze counterface. The use of such a seal is a guarantee of high efficiency and continuous service without attention.

The pump is available either for $\frac{3}{4}$ or 1-in. B.S.P. connections, and drain plugs are fitted to give protection from freezing in cold weather. Standard motor voltages are 200 to 220, 230 to 250, 50 cycles, single phase. A 60-cycle unit will be available shortly.

The pump is self priming to a suction lift of 25 ft. and will generate a total head of 100 ft. The maximum output from the pump is 500 gal./hr.

CPE 237

'Alcon' self-priming electric pump.

New slotted angles

Two new items have been added to the *Supaslot* range of slotted angles. The first is heavy industrial angle made from 10-gauge, or $\frac{1}{8}$-in., hot-rolled steel measuring $1\frac{1}{2} \times 1\frac{1}{2}$ in. This very heavy angle is immensely strong and the manufacturers envisage a completely new field of use for this product. Hitherto the standard slotted angle of 14 gauge has been considered insufficiently strong for many of the more ambitious structures such as buildings, roof trusses, heavy production benches and racking to carry exceptionally heavy loads such as steel bars.

The other slotted angle in this range is *Supaslot* 'Minor,' which is also $1\frac{1}{2} \times 1\frac{1}{2}$ in., but this product, being of 14 gauge, is for the more normal structures usually associated with slotted angle, such as racking and shelving. For this particular application the manufacturers have also introduced a range of direct-bolt-on shelves all measuring 36 in. in width, but varying in depth. **CPE 238**

Flameproof 'Annunciator' warns of hazardous atmospheres

In many processing plants it is essential that a preliminary warning be given of a possible undesirable condition arising, in order to avoid a shut down of the plant. Such warning is all the more essential in plants working in hazardous atmospheres. For this purpose, the flameproof *Annunciator* has been designed to give a double warning, by means of a light and a horn, before the failure occurs.

The impulse for the operation of the warning device is given through a remote relay, itself operated as a result, for instance, of pre-set temperature or pressure, or pre-set levels in the case of liquids, or by the position of an actuating arm on some part of the plant. The *Annunciator* itself is suitable for wall or switchboard mounting, with provision, if required, for access from the rear as well as the front. Various designs are available for specific purposes. In the apparatus illustrated, two white lights are visible, and a two-position switch, marked 'normal' and 'fault' is provided; the horn is mounted at any desired position outside the apparatus.

When all conditions are normal and the plant healthy, both lights are off and the horn is, of course, silent. Should a fault occur in the plant, a contact (outside the *Annunciator* unit) is made to open; this results in both lights coming on and the horn sounding. The warning thus having been given to the maintenance personnel, the switch is turned manually to the 'fault' position; this puts out the right-hand light and silences the horn, but the left-hand light remains on as a continuous warning that the fault condition prevails though is being attended to.

When the fault has been cleared, the left-hand light goes off, the right-hand light comes on again and the horn sounds again. The switch is then returned manually to the 'normal' position, which silences the horn and puts out the right-hand light, so that lights and horn now show once again a restored healthy condition of the plant.

The enclosure is of cast aluminium having overall dimensions, in the case of the particular *Annunciator* described, of approximately 12 in. × 6 in. × 6 in. It is certified flameproof and covered by certificates FLP 3604 for Group I and FLP 3605 for Groups II and III.

Variations of this *Annunciator* design are available in other enclosures; these are either with two lights or three lights of different colours, the preliminary warning being given by a flashing light as well as by the horn.

CPE 239

Flameproof 'Annunciator'

New three-specimen spectrograph

The new *Norelco* three-specimen inverted spectrograph is designed so that the *x*-ray beam strikes specimens from the bottom and it can be used for analysis of metals, powders and liquids such as heavy waxes and oils.

The instrument has three specimen holders measuring $1\frac{3}{8}$-in. diameter by $1\frac{3}{8}$-in. deep which fit into a horizontal disc that rotates inside a leaded-bronze ray-proof housing. The disc shaft extends through the top of the housing and has a knob which the operator turns manually when he wishes to change specimen positions. An indexing device centres each specimen when over the beam and shows whether it is No. 1, 2 or 3.

Specimen holders have $\frac{1}{4}$-mil-thick *Mylar* windows held in place with retaining rings to facilitate replacement. A nickel foil collimator with $\frac{1}{8}$-in. spacing is built into the instrument. Pedestal height and base are designed to accommodate the standard *Norelco* wide-range goniometer.

Special accessories are available for use with the instrument. One attach-

ment provides a synchronous motor for rotating the specimen approximately 78 r.p.m. Another attachment makes it possible to employ a helium atmosphere. Another allows specimens to be heated while in the chamber.

CPE 240

Protection of storage tanks

Outside chemical storage tanks, ranging up to 1,000 gal. in capacity, can now be protected against the corrosive products they contain with a new entry to the protective coatings field—fluorocarbon plastic coatings based on *Kel-F* dispersions.

These new dispersions are finely divided fluorocarbon plastic solids in a volatile medium. Applied by spray, dip or spread coating, they are fused by heat into a tough, impervious coating, firmly bonded to the surface on which they are applied, and providing a chemical- and temperature-resistant surface that is anti-sticking and self-cleaning.

Baking is said to produce a tough, adherent, continuous coating with high resistance to temperatures approaching 400°F., and low-temperature flexibility; resistance to chemicals, including alkalis, mineral acids, strong oxidising acids and solvents; low permeability to moisture, organic and inorganic liquids and vapours; high abrasion resistance and tensile strength; low cold flow and high impact resistance; high dielectric strength and electrical resistivity; and non-toxic characteristics. **CPE 241**

Fume removal

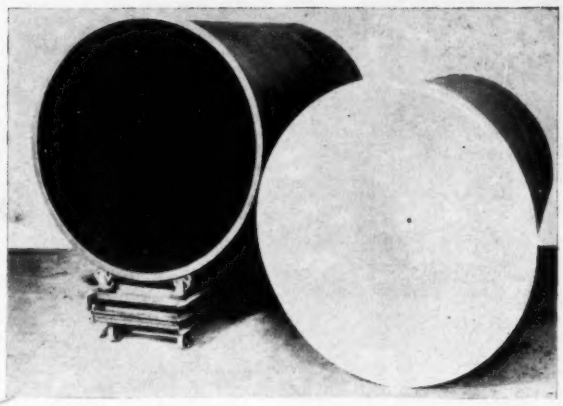
With the introduction of the *Tornado* range of bifurcated fans to the British market, a new design of fan was brought to bear on the problem of industrial fume removal. It obviates the need for other expensive axial fan arrangements, such as V-rope or extended spindle drives and, at times, centrifugal fans used for removing obnoxious fumes from industrial processes.

The bifurcated design of fan casing allows the easily accessible, direct-driving motor to be completely isolated from, and therefore unaffected by, the fumes passing through the casing. This standard range is constructed with welded steel casings and cast silicon-aluminium impellers in sizes from 10 to 25-in. diameter. They are normally coated with a sprayed enamel finish, but when working under more arduous conditions additional protection is given to the internal surfaces by a rubber covering or liquid plastic coating.

Now, however, bifurcated fans are being made with solid PVC casings and impellers, and are stated to be particularly suitable for the handling of corrosive fumes. *Tornado* PVC bifurcated fans are also quieter in operation and comparable in price with the alternative, specially-coated steel-plate fans.

The new range is available in sizes from 10 to 19 in., and single- or three-phase, totally enclosed, squirrel cage induction motors are used throughout the range. To complete the service, the manufacturers also undertake the accurate design and production of hoods and ducting in rigid, anti-corrosive PVC, thus offering a fume-extraction plant completely resistant to corrosive attack.

CPE 242



Chemical storage tanks protected with fluorocarbon plastic coatings. *Right:* Coated with an unbaked dispersion. *Left:* After the applied coating has been fused to an homogeneous impermeable film.

A 12-in.-diameter 'Tornado' bifurcated fan with casing and impeller of rigid, solid PVC for the extraction of corrosive fumes.

Stud welding 40-ton steel

For many years there has been a demand from industry for stud welding attachments made of a material as readily weldable as mild steel, but having a greater tensile strength. Consequently, with the advent of low-alloy, high-tensile steels, such as *Fortiweld*, tests were carried out to ascertain the suitability of such new materials for stud welding.

These tests proved eminently worth while and, as a result, studs and attachments have now been developed which are made of a high-tensile steel and are weldable with the standard *Cyc-Arc* and Nelson stud welding equipments. Of particular interest to the user of such equipment is the fact that no special stud welding techniques are required, the present methods employed on mild steel being entirely suitable.

Typical chemical analyses of the types of steels employed for the studs shows a carbon content of 0.08 to 0.12 with 0.43% molybdenum and .0026 to 0.0046% boron added, giving a T.S. of 42 tons/sq.in. and about 68% reduction of area. All stud welding tests carried out have proved that the welds are stronger than the studs themselves, and 90° bends showed no evidence of cracking.

In addition to the above excellent physical properties, it is claimed that the new stud material shows greatly increased fatigue and heat resistance, compared to the 0.35C type of mild steel. The stress to rupture is still in the region of 26 tons/sq.in. after 1,000 hours at 500°C. Moreover, it is claimed, the material has a high ductility which ensures high-quality welds.

An interesting development is in the use of 40-ton steel for stud welding

plate-headed studs on chemical vessels. These studs secure the refractory lining to the walls of the vessel and the heat-resisting properties of the material are thus fully utilised.

CPE 243

Steam safety valve with full nozzle

A full-nozzle, full-lift steam safety valve marketed by a British firm is now fully recognised for insurance purposes by both Lloyds Register of Shipping and the Associated Offices Technical Committee, who represent the main boiler insurance companies of Great Britain. The makers point out that, in addition to the high relieving capacity, these safety valves also have the advantage that the nozzle and disc are both provided with flat seats which, as well as ensuring a tight shut off, considerably simplify maintenance should seat resurfacing become necessary.

These safety valves are provided with adjusting rings on both nozzle and guide, enabling very low blowdown to be achieved in addition to really positive opening and closing of the valve under all operating conditions.

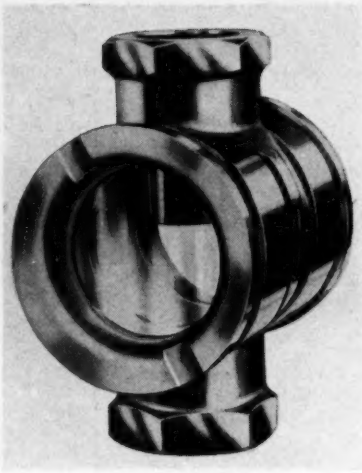
The pressure joint between the safety valve and the boiler is made on the nozzle flange, so that only the stainless-steel nozzle and disc are subjected to pressure when the valve is closed. In addition, this nozzle is loosely fitted into the body, preventing the possibility of any stresses due to non-uniform temperature expansion of the body being transmitted to and causing distortion of the nozzle.

CPE 244

Karl Fischer titrations

An instrument for carrying out Karl Fischer titrations automatically will be in production shortly.

It is claimed that the apparatus can be used by a relatively unskilled operator who, having placed the sample to be tested in the vessel of the apparatus, can carry out the titration merely by pressing a button. The titration proceeds automatically and stops automatically when the end point is reached. The burettes can also be refilled automatically by pressing a button. This instrument is the first of a series of *Analmatic* instruments. **CPE 245**



'Bowser' sight glass.

Flow indicator

A new flow indicating device, the Fig. 55A *Bowser* flow sight, is made in bronze and is of the double-window, clear-vision type. Equipped with a nozzle on the inlet side to cause the liquid to flow downward in a round stream without contacting the glasses, the sight is recommended for use on gravity lines where the flow is vertically downwards. It can also be used on pressure lines for observing the clarity of the liquid.

An important feature is the method of retaining the glass; the retainer, being threaded on the outside, permits rapid and uniform circumferential tightening. There are no bolts to cause uneven pressure and resulting glass breakage.

Used on cooling water lines, oil lines, coolant system lines and for a variety of other liquids, the Fig. 55A *Bowser* flow sight is made at the moment in $\frac{3}{4}$-in. pipe size, but later will be made in larger sizes and in other materials. Maximum pressure for standard model is 125 p.s.i., it is fitted with heavy plate glass and is threaded with female connections.

CPE 246

High pressure swivel pipe coupling

A range of high-pressure swivel pipe couplings is now being developed and produced under the name of the *Avica* coupling. The coupling, it is claimed, when pressurised to 4,000 p.s.i., permits the shaft to rotate with a maximum of 8 lb.in. torque, which in production varies from as low as 2 lb.in. up to the maximum. It is believed that this is the lowest torque that has been achieved in a coupling of this type.

In piping up hydraulic systems for each new type of aircraft, or auxiliary system, it has been found necessary to 'tailor' the basic design to suit (*a*) local space limitations, (*b*) available attachment points, and (*c*) the method of using the principle of swivel pipe couplings in conjunction with either rigid tubing or flexible tubing. While the interior arrangement of parts remains unaltered, the externals of both body and rotating shaft may conveniently be tailored into the system. Compactness of installation and weight saving may be achieved in certain cases by disposing of the body component altogether, and arranging for the jack or ram, or other item of equipment, to have the necessary dimensions machined right in to take the rotating shaft, ball race, gland, retaining cap nut, etc. It is also possible to position the body component to one side of a rib or bulkhead with only the shaft protruding through. One virtue of the low turning torque claimed for the *Avica* coupling is that it can be coupled to a conventional flexible pipe which may 'drive' or rotate the shaft, at high pressure, while imposing the minimum bending load or destructive influence upon the flexible hose.

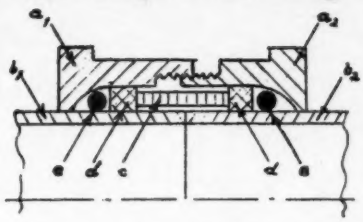
Originally, the basic design was tested for reliability at 4,000 p.s.i., using hydraulic fluid, but subsequent testing has evaluated the coupling at static and impulsing pressures up to 6,000 p.s.i. over a temperature range from −50°C. to +80°C. from the points of view of torque variations with temperature changes and life of the gland under oscillating movements of the shaft component.

Further testing has been carried out to determine pressure drop across the end couplings at low and high pressures, and the design has been found suitable for service with air, fuel or hydraulic fluid at an operating pressure of only 50 p.s.i. over a temperature range from −62°C. to +70°C. Endurance testing has resulted in 'lives' being obtained well in excess of the requirement for the majority of aircraft components. Work is under way at the moment to evaluate the design with the non-inflammable hydraulic fluids, Shell H-2 and *Skydrol* 500, at 4,000 p.s.i., while for specialised applications couplings are being tested with air at 2,000 p.s.i., water at 20,000 p.s.i. (no rotation at this pressure) and for their flame resistance. **CPE 247**

Joining Pipes Without Welding or Brazing

Without welding or brazing, flangeless or threadless tubing can be joined by means of the sleeves developed by a German tool manufacturer, Werkzeugfabrik G. Rathke & Co., Hamburg.

This pipe coupling consists of a pair of threaded sleeves which are connected by screwing (see figure). The mode of operation of this coupling is based upon the bore of the sleeves being tapered, so that their inside diameters gradually decrease towards their outside ends which fit closely to the outside diameters of the pipes to be connected. Between the sleeves (a_1 and a_2) and the pipes (b_1 and b_2) a short bushing (c) with a sealing ring (d) and a clamping ring (e) on each end is arranged directly over the joint. By screwing together the sleeves, the sealing rings are pressed by the clamping rings from both sides on to the bushing, and deformed. Thus both ends of the bushing are sealed. The clamping rings are slightly pressed into the pipe wall, thus preventing axial pull out of the pipes.



Tests carried out by the Werkstoffprüfamt (office for testing materials), Hamburg, on pipes of an inside diameter of about 32 mm. showed an axial displacement only at high pressures—using copper sealing rings at 350 atm. and, at 480 atm., using iron-sheet sealings. Joining pipes is considerably simplified by these sleeves, because there is no need for flanges or threads.

In addition, this pipe coupling is especially advantageous when welding is not allowable because of explosion risks and when the coupling may need to be disconnected.—E.P.A. digest from *Hansa*, 1955, **92**, 255, and *Umschau (Germany)*, 1955, **13**, 411.

Book Review:

Sonics and Ultrasonics

WITHOUT hesitation one can say that the authors of both these works*† have plenty to give to those with a thirst for knowledge. The basic difference between the approach of the American authors (one of them a German scientist now residing in the U.S.) and the English one is that the first have chosen critical assessment while the latter has, on the whole, confined himself to an excellent job of reporting.

The Americans do not 'assume knowledge of acoustics but of electronics' and Mr. Crawford has also no hestitation in laying particular stress on electronic means of generation. But Hueter and Bolt define sonics as 'the technology of sound as applied to problems of measurements, control and processing' and they admit from the outset that 'literature (is) sprinkled with misconceptions, unjustified optimism and speculations.' '(It) might lead one to believe that sonics is a panacea for all unsolved problems of industry.' 'Even more important than the validity (of experimental work) is the economic competitiveness of any proposed technique. Many processes that "work" in the laboratory must fall by the wayside simply because in full-scale application they cost too much.' Having said this, they go on to survey a number of applications which do not seem particularly promising, *e.g.* clothes washing and aerosol agglomeration.

The similarity of the layout of these books shows the trend of thinking among workers in sonics and ultrasonics at the present time. After considering basic principles, the Americans are most concerned with the theoretical aspects of radiation, while Mr. Crawford gives an excellently presented version of the recent work on cavitation by Mr. G. W. Willard. Cavitation is also given its important place later in the Americans' book and it is common ground among all interested parties that this is indeed one of the most outstanding physical mechanisms forming the basis of the efficiency of sonic systems. Then they both deal in separate chapters with piezzo-electric transducers and magneto-strictive transducers. The latter can successfully be used for welding and drilling also on an industrial scale. Some other uses, including the ageing of wines and spirits, depolymerisation of dextran, electroplating and sterilisation, can only be considered as economically unsound, speculative or amusing.

The last chapter in each book turns to 'Principles of Sonic Testing and Analysis' and 'Ultrasonic Instruments and Control Gear,' respectively. These will be of passing interest because of the possibilities of flowmeters and viscometers based on ultrasonic principles. Other uses described therein are of little direct interest to the chemical engineer. Metal testing comes into this category, gas analysis is hardly more than of theoretical importance, medical diagnosis is completely out of our range of discussion and fish location similarly.

The most important part of the American book to the practising chemical engineer is the seventh chapter entitled 'Devices and Techniques for Sonic Processing.' Mr. Crawford scores heavily because he uses seven chapters to deal with the various aspects of information about the applications of sound waves in the laboratory and in industry.

Where useful work is done by means of sound waves, every possible application is interesting because it might have a bearing on some industrial process sooner or later. Hueter and Bolt and Crawford come down heavily in favour of whistles and jet generators for emulsification and homogenisation. Mr. Crawford has made the survey of this aspect of ultrasonic technique more difficult to follow because he puts part of the information not into chapter 8 but into chapter 5, which was to have dealt with the underlying principles of 'jet generators' rather than with their application. But we need not quibble about procedure, because one also cannot agree with many of the examples of successful cases, knowing of the actual work done in industry and the vastly superior results which are obtained. However, so much individual intelligence cannot be adequately reported until years after a particular process has been established, and Mr. Crawford must be thanked and congratulated upon his skill and diligence in presenting such a wealth of detail.

The references quoted in both books are interesting but rather erratic, because they sometimes go back to the time of the Curies and then suddenly become quite up to date. The wealth of literature available obviously makes selection a very onerous task, and

(*Concluded on page* 182)

*'Sonics,' by T. F. Hueter and R. H. Bolt. Chapman & Hall, 1955. Pp. 456, inc. index, 80s.

†'Ultrasonic Engineering,' by A. E. Crawford. Butterworth Scientific Publications, 1955. Pp. 344, inc. index, 45s.

British Patent Claims

The following are abstracts of some recent British patents which will be of interest to our readers. These abstracts are reproduced from the weekly Patents Abstracts Journal *by permission of the Technical Information Co. The complete specifications can be obtained from the Patent Office, 25 Southampton Buildings, London, W.C.2, price 3s. each.*

Treatment of sulphite waste liquor

Conversion of sulphite waste liquor to a solid material, useful as a fuel or fertiliser, by evaporating the liquor in bulk in a multistage vacuum evaporator up to a water content of 20 to 40% by volume, further reducing the water content to 10 to 20% in a film evaporator, the *p*H having been maintained between 5 and 6 in both concentration stages, and then adjusting the *p*H to about 7.2 to 8 by mixing it in a planetary mixer at 70 to 100°C. with calcium hydroxide.—744,575, *J. R. Schnell et al.* (*Switzerland*).

Chlorination of titaniferous materials

Static-bed process for chlorinating a titaniferous iron material to produce $TiCl_4$. Briquettes of the titaniferous material with a carbonaceous material are reacted with excess chlorine in a static bed at 500 to 800°C. to produce volatile chlorides of Ti and Fe and tail gases containing Cl_2, CO and CO_2, and a residue comprising lumps of unchlorinated and partially chlorinated briquettes and dust-like gangue. The Ti and Fe chlorides are separated from the tail gases which are then used to chlorinate the unreacted briquettes after they have been separated from the gangue.—744,415, *National Lead Co.* (*U.S.*).

Washing and cooling of roaster gases

Roasting and combustion gases containing SO_2 are directly treated with a cooling and washing liquid in a separate cycle for each stage to obtain pure SO_2. In the first stage the used cooling and washing liquid is itself subjected to direct cooling and sensible heat is converted to latent heat by evaporation of water, and in the further stage(s) heat is indirectly removed from the washing liquid by the use of cooling surfaces.—744,465, *Dr. A. Chemiebau, Zieren Ges.* (*Germany*).

Recovery of salts from aqueous solutions

Salts heavier than water are separated from acidic or basic aqueous solutions by subjecting such solutions to adiabatic flash partial evaporation in a vacuum chamber containing a liquid bath covered with ice crystals, while maintaining a sub-atmospheric pressure which causes part of the remaining water to freeze and the salts to be thrown out. The resultant slurry is allowed to fall into the bath for separation, where the ice floats and the salts sink.—744,430, *Farbenfabriken Bayer Akt.-Ges.* (*Germany*).

Crystallisation process

Crystallisation process in which an essentially hydrocarbon mother liquor is agitated during crystal formation by pulsating it at 20 to 300 pulses/min., successive pulses being directionally opposite to one another and each pulse imparting a uniform flow movement between $\frac{1}{4}$ and 4 in. in amplitude to the entire liquor mass. Particularly applicable to the crystallisation of hydrocarbon wax from mineral oils.—744,482, *Esso Research & Engineering Co.* (*U.S.*).

Anion-exchange resins

Highly basic resin consisting of a quaternary ammonium base or salt of a copolymer of a vinyl-alkyl substituted, nitrogen-containing heterocyclic compound, in which at least one alkyl carries a tertiary amino group (*e.g.* 5-vinyl-2-methyl pyridine) and an unsaturated organic compound (*e.g.* divinyl benzene).—744,386, *Permutit Co.* (*U.S.*).

Polymerisation process

Continuous emulsion or solution polymerisation process particularly of acrylonitrile, in which the deposition of polymer in selected zones of the system other than the polymerisation zone, *e.g.* heat-exchange zones, is inhibited by introduction of O_2N_2O or NO (*cf.* Brit. Pat. 735,225).—744,504, *American Cyanamid Co.* (*U.S.*).

Synthetic rubber

Copolymerisation of an iso-olefine of 4 or 5 C atoms and an aliphatic conjugated diolefine in the presence of a liquid which is a solvent for the monomers and polymer, using 55 to 90%wt. of monomers in the polymerisation feed, at below –50°C., using a Friedel Craft catalyst, and taking the percentage conversion not higher than $1{,}000/M$, where M is the percentage of monomer in the feed (*cf.* Brit. Pat. 595,120).—744,514, *Esso Research & Engineering Co.* (*U.S.*).

Electrically heated pipe

A pipe (*e.g.* for viscous liquids) is corrugated and has an insulated heating wire(s) accommodated in the external trough(s) formed by the corrugations. — 744,435, *Pirelli-General Cable Works Ltd.*

Calcining, etc., process

Ore, lime, clay, etc., is fed to an elongated perforated trough which is swingingly shaken intermittently to cause the material to progress stepwise through a heat-treatment zone while on the trough.—744,603, *O. Kaufmann.*

Grinding mill

In a coupled four-roller grain, etc., mill having two co-acting pairs of rollers, of which the slow rollers are driven from the respectively opposite fast rollers (or *vice versa*), the electrical driving means comprises a power source(s) having two take-offs in unvariable-speed relationship for the two directly driven rollers.—744,611, *Buhler Geb.* (*Switzerland*).

Rotary pump

In Brit. Pat. 744,413, a resilient flexible passageway which is compressed by a rolling member has a track for contact with such member, the track varying in thickness radially, so that its co-action with the member and the resilient flexible material causes a predetermined degree and extent of compression thereof. In Brit. Pat. 744,414, the roller(s) of the rolling member is resiliently mounted to yield in a radial direction relative to the rotary member which supports it. —744,413 *and* 744,414, *R. C. Ford.*

Continuous pressure filter

The extent of opening of a variable sludge outlet valve is controlled by a device operated by the resistance offered by the sludge to a continuously operating mechanism for feeding the sludge to the outlet.—744,372, *G. Moss.*

Fractional separation of granular material

A reciprocatory or vibratory trough separates mixed granular material fed thereto (*e.g.* contaminated grain) into layers, the dense material being fed endwise from the trough and the lighter material being delivered over the trough sides by flow-obstructing means operating on the upper layer.—744,649, *C. H. J. V. Phillips.*

★ Personal Paragraphs ★

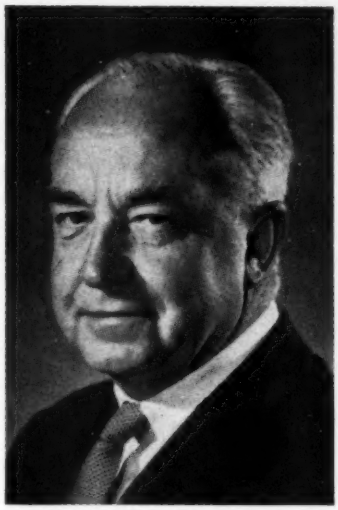
★ **Sir Miles Thomas,** who has occupied the position of chairman and chief executive of British Overseas Airways Corporation for the past seven years, has been appointed a director of Monsanto Chemicals Ltd. **Mr. E. A. O'Neal, Jun.,** has informed the board that, in view of the call of his duties in America as a director of Monsanto Chemical Co., U.S., he will be unable to continue as chairman of the board. He is therefore resigning this office with effect not later than June 30, 1956. He will remain a director of Monsanto Chemicals Ltd. Sir Miles Thomas has accepted the board's invitation to become chairman in succession to Mr. O'Neal. He will assume this office not later than July 1, 1956, taking up full-time service with the company.

★ **Mr. W. B. H. Gallwey** has been elected chairman of British Acheson Electrodes Ltd. He succeeds **Sir Arthur Matthews,** O.B.E. Mr. Gallwey was born and educated in Newcastle-on-Tyne, and his connection with Union Carbide & Carbon Corporation, New York (who have the major shareholding in British Acheson Electrodes Ltd.) directly or indirectly dates from March 1928, when he joined 'Gemec' organisation, London. In June 1947 he was appointed managing director of British Acheson Electrodes Ltd., Sheffield, and in February 1954, director of Union Carbide Ltd., London. In June 1955 he was appointed managing director, Union Carbide Ltd., and in June 1955 elected a member of the board of Gemec Ltd. and appointed managing director.

★ The United Steel Companies Ltd. announce that **Mr. S. R. Howes,** at present director and general manager of Samuel Fox & Co. Ltd., is to retire on June 30. He will remain on the board of Samuel Fox & Co. Ltd. Mr. Howes will be succeeded by **Mr. H. P. Forder,** at present director and deputy general manager of the branch.

★ **Mr. H. J. Taylor** has been appointed manager of the Hadyn Park works of Johnson, Matthey & Co. Ltd. at Shepherds Bush, London. He succeeds **Mr. A. Godden** in that appointment.

★ At the annual general meeting of the Chemical Society the following elections were declared: president, **Prof. E. L. Hirst;** honorary secretary, **Dr. J. Chatt;** vice-president, **Prof. E. D. Hughes;** members of council, **Prof. R. M. Barrer** (London), **Prof. A. G. Evans** (Cardiff), **Prof. L. Hunter** (Leicester), **Dr. G. W. Kenner** (Cambridge), **Prof. B. Lythgoe** (Leeds), **Dr. A. Maccoll** (London) and **Mr. L. A. K. Stavely** (Oxford).



Sir Miles Thomas.

★ Following the retirement of **Mr. William E. Jenkins,** C.B.E., from his position as a managing director of Esso Petroleum Co. Ltd., **Mr. H. C. Tett** and **Mr. R. J. Pinder** have been appointed managing directors. At the same time, **Mr. C. Chilvers,** manager, co-ordination and economics department, has been appointed to the board.

Mr. W. B. H. Gallwey.

★ **Sir Henry Tizard,** G.C.B., A.F.C., has been appointed to the board of Marchon Products Ltd. Already a director of Solway Chemicals Ltd., he is also a director of Albright & Wilson Ltd., and a member of the National Research Development Corporation.

★ **Mr. H. R. Burkinshaw** has been appointed manager of the London office of Edgar Allen & Co. Ltd. He joined the firm in 1917 and was first employed in the steel foundry and later the steel department, but in 1922 joined Jessop & Co. Ltd., Edgar Allen's Calcutta agents, becoming a managing director in 1946 until his retirement in 1955. **Mr. H. R. Beken** has retired as manager of Edgar Allen's London office.

★ **Mr. F. S. Stent** will be manager of the new materials handling division formed by Babcock & Wilcox (referred to on another page). At present he is a director of the Marco Conveyor & Engineering Co. Ltd. and well known to the industry for his activities in connection with the Mechanical Handling Engineers' Association. **Mr. R. A. Taylor,** hitherto in charge of the conveyor department of Babcock & Wilcox, has been appointed chief technical advisor to the new division. Mr. Taylor is well known to the industry for his developments in the tandem driving of heavy belt conveyors and on the avoidance of the segregation of coal during handling.

★ We regret to announce the death of **Mr. E. Harley Bell,** managing director of Radiovisor Parent Ltd.

★ B.I.S.R.A. Council has appointed **Dr. J. Pearson** as assistant director of research. He will continue his present duties as head of B.I.S.R.A.'s steelmaking division and chemistry department.

★ The following new appointments are announced by the Mond Nickel Co.: **Mr. G. L. Harrison** will succeed Mr. A. D. Busby as development metallurgist in London, and **Mr. P. D. Wilmot** will join the company as development chemist.

★ **Mr. Ralph H. Atkinson,** a native of England, has retired as head of the platinum metals section of the International Nickel Co.'s research laboratory at Bayonne, New Jersey, after more than 30 years' service with the Mond Nickel Co. Ltd. in the United Kingdom, and its Inco affiliates in the United States and Canada.

World News

GREAT BRITAIN

Esso Petroleum Co. forms chemical department

With the recently announced expansion of facilities at the Esso refinery, Fawley, to produce large volumes of raw materials suitable for chemical synthesis, Esso Petroleum Co. has established a chemical department specifically to market these products to the United Kingdom chemical industry.

Manager of the new department is Mr. T. C. G. Thorpe, formerly manager of the wholesale department. Mr. A. A. Appleton, formerly assistant technical superintendent at the Esso refinery, has been appointed assistant manager. Dr. E. J. Boorman, formerly assistant manager and chief chemist, technical sales department, succeeds Mr. Thorpe as manager, wholesale department.

Babcock form new division

Babcock & Wilcox Ltd. announce the formation of a materials handling division, which will co-ordinate in one group the various functions hitherto performed by separate departments. The new division will deal with all types of materials handling, including conveyors, together with *Hydrojet* and *Hydrovac* ash and dust handling plant, and a new low-pressure pneumatic fly ash handling system, but not with cranes or furnace-charging equipment, which will still be the province of the crane department, as at present. The new division will be officially formed in June and will be accommodated at Lynton House, Tavistock Square W.C.1 (phone EUS 4321). Members of the division will represent Babcock & Wilcox Ltd. in the Mechanical Handling Engineers' Association.

Instrumentation and industry

A continuing acceleration in the demand for industrial instrumentation was forecast by Mr. E. C. Vorlander, managing director of Honeywell-Brown Ltd., when addressing a sales conference recently. Instrumentation, as a means of increasing productivity, improving quality and reducing production costs, was vital to the nation's economy, he said.

V. D. MacLachlan, sales director of the company, presided over the two-day conference, which was attended by industry sales managers and managers of the company's seven area offices.

Kent oil refinery extensions

The engineering of the offsite facilities required in connection with the £26 million expansion programme recently announced by the British Petroleum Co. Ltd. for increasing the rate of processing crude oil at Kent oil refinery from 4½ million to 7 million tons p.a., and also in connection with the aviation gasoline plant already announced, has been awarded jointly to W. J. Fraser & Co. Ltd. and the Power-Gas Corporation Ltd. Supervision and inspection of construction will be co-ordinated from the site office in close collaboration with B.P. construction staff. The work involved consists of conveying crude oil to new distillation equipment and removing the products to intermediate storage and to other specialised plant for further processing. Final product tankage and despatch facilities will also be provided, together with facilities for supplying the new plants with services such as steam, power, cooling water, etc.

The value of the work to be handled under this contract is of the order of £8 million.

Belgian oil refinery contract

The M. W. Kellogg Co.'s wholly owned subsidiary, Kellogg International Corporation, with headquarters in London, has been awarded a contract by Raffinerie Belge de Petroles, Antwerp, for the design and construction of a combined catalytic desulphuriser and catalytic reforming unit. The units are expected to go on stream in the latter part of this year. This will be the first unit in Europe designed by Kellogg to utilise the new Sinclair-Baker RD-150 platinum reforming catalyst.

A full-range straight-run naphtha from Middle East crude will be catalytically desulphurised, and will then be fractionated into light and heavy cuts. The light cut will be 'doctor-sweet,' light, straight-run gasoline requiring only stabilisation to form a finished product, and the heavy cut will be reformed in the presence of hydrogen-rich make gas over the platinum catalyst to produce a high-octane reformate.

It is stated that this process is capable of producing reformates of F-1 clear octane numbers as high as 100 from Middle East feedstocks.

Harwell to show (some of) its secrets

The Atomic Energy Research Establishment at Harwell was founded in 1946 and, to mark the passing of the first ten years, a series of 'open days' is to be held in the week ending June 2.

As a result of the changes in security classification made before the International Conference on the Peaceful Uses of Atomic Energy at Geneva last year, much of the work at the Establishment is no longer subject to security restrictions. Consequently, visitors will have more freedom to see a wider range of work at Harwell than was possible until recently.

Johnson, Matthey and inflation battle

Johnson, Matthey & Co. Ltd. have distributed to their customers a letter stating that the company has decided to assist, to the best of its ability, the Government's endeavour to halt the progress of inflation.

The letter points out that the prices of most of the company's products include, as a major part, the prices of the precious or other metals contained in them. Since the company does not control the price of any of the metals it handles it cannot avoid varying its selling prices to the extent of any variations in the actual price of these metals.

What it can control, however, the letter goes on, is the remaining part of the company's selling prices, which represents its charge for the work it performs. It has been decided, therefore, that the company's refining and manufacturing charges will not be increased during a period of six months from February 1, 1956, and that at the end of that period the possible extension of this undertaking for a further six months will be considered in the light of conditions then obtaining.

Industrial oils expansion

Increased production of industrial cutting oils (and of specialised and general-purpose oils also) will result from the reorganisation and expansion programme announced by Amber Chemical Industries Ltd. A new company—Amber Oils Ltd.—has been formed to handle the entire oil side of the original company, the Amber Chemical Co. Ltd. To this new subsidiary has been assigned the production and sale of the main types of cutting oil used by industry, of specialised oils (for heat treatment and wire drawing) and of general-purpose oils (lubricants, etc.).

£40 million worth of exports

Materials and equipment worth £40 million were exported from the United Kingdom during 1955 by the Royal Dutch/Shell Group of oil companies for their operations overseas. This amount was £9 million more than in 1954 and represented about 1.1% of total U.K. exports. In addition, £10 million was spent on plant and stores to maintain and improve refineries in this country and £18½ million on the construction, repair and victualling of the Shell tanker fleet.

Export orders were placed with over 4,000 U.K. suppliers, six of whom received business valued at over £1 million each and 75 over £100,000 each. In the main, however, purchases were widely spread among suppliers, of whom some 3,500 received orders for under £5,000. Shipments totalling 236,000 tons were made to destinations in over 100 countries, involving payment of £3¼ million in freight to British shipowners.

Among the more unusual items sent out were hoppers (containers) for refinery catalyst, shipped to the Netherlands, West Indies and Venezuela in sections each the size of a small house.

UP SHE GOES

A section of a catalyst hopper being loaded aboard a cargo ship on the Tees estuary at Middlesborough. A number of such hoppers have been exported by the Royal Dutch/Shell Group.

New oxygen works

A new works which has been built on a 6-acre site in the Milton of Craigie area of Dundee is capable of compressing 500,000 cu.ft./week of oxygen into cylinders for distribution to customers along with other industrial gases which they require. The works is owned by the British Oxygen Co., who have supplied compressed oxygen from a works in the harbour area of Dundee for a considerable number of years. It was recently found that the facilities were inadequate for the volume of business.

It was also decided to produce dissolved acetylene in Dundee, and the new works includes a plant for this purpose with the capacity of 350,000 cu.ft./week.

I.Chem.E. examination

The Institution of Chemical Engineers is now receiving applications for entrance to the 1956 examination. Forms, which are returnable not later than June 1, may be obtained from the General Secretary at 56 Victoria Street, London, S.W.1. In applying for forms applicants should state which parts of the examination they propose to take.

SOUTH AFRICA

Sulphuric acid plant

The only Petersen sulphuric acid plant in Africa has started production at the Umbogintwini factory of African Explosives & Chemical Industries in Natal. The plant, including the equipment for burning pyrites, cost £2 million, and is said to be among the biggest of its type in the world. Most of the material used in its construction was South African, though some of the pyrites-burning equipment came from the United Kingdom. Dr. G. Petersen, son of Dr. Hugo Petersen, inventor of the Petersen process, came to South Africa to supervise the starting up of the plant at Umbogintwini and has now returned to Germany.

DENMARK

Pyrolitic gasworks

It is now generally expected that the A. P. Moller pyrolytic gasworks in Amager are not likely to come into operation until late this year. The works were reported to have started operation in November last, but this was confined to an unsuccessful trial run only. The cost of the whole works will be considerably in excess of the original estimate of 40 million kroner.

FRANCE

Good year for Pechiney

The French industrial concern, Pechiney, a large producer of aluminium, chemicals, ferro-alloys and other goods, increased its sales last year. The chairman, M. Piaton, reported that the company's turnover rose by 24% compared with 1954, despite price cuts for certain products, while exports increased from 18% of production to 22%. This was due mainly to completion of the company's first modernisation programme started in 1949, which enabled plants to expand both production and productivity, particularly in the field of plastics and aluminium. Even so, output of aluminium and certain chemicals lagged behind demand, M. Piaton said.

Aluminium production increased by 9% to 107,920 tons from 99,000 tons in 1954. Sales of ferro-alloys and silicon doubled, export sales being particularly good. Output of bauxite rose by 18%, alumina by 7% and graphite by 24%, while chlorine production was stepped up from 36,000 to 53,000 tons with the help of a new electrolytic plant in Saint-Auban. The volume of chemical sales rose by 42% for miscellaneous alumina, 18% for chlorine solvents, 55% for polystyrene and 50% for insecticides.

Pure plutonium by industrial process

France will be able to produce pure plutonium by an industrial process in two years' time, M. Francis Perrin, High Commissioner of the French Atomic Energy Commission, has announced.

The making of plutonium, an artificial metal derived from uranium 238, is at present in the laboratory stage. The second step, transforming plutonium oxide into pure metal by an industrial process, will be ready in 1958, M. Perrin told the French Science Academy.

NORWAY

Aluminium plant

The Norwegian Parliament recently approved plans for building a big new aluminium plant at Mosjöen, north Norway. Initial output will be about 20,000 tons p.a. of aluminium. The plant will be built by the industrial concern, Elektrokemisk A/S, and will be powered by electricity from the State hydroelectric station at Rössaga, which also generates power to the new steel plant at Mo i Rana. The aluminium plant, involving an investment of £7½ million, is expected to be in production by 1958-59.

ALBANIA

New industrial projects

Albania is to raise her oil output by 156% during the next five years, according to draft directives for the country's second five-year plan. The main tasks of the country's economic development as outlined in the draft directives are:

Further development of industry, particularly the mining industry, by fully marshalling existing production capacities and the mobilisation of the reserves in the country; and the rapid development of agriculture, mainly through a reorganisation of agricultural production on a Socialist basis.

During the second five-year plan the value of industrial production, on the basis of 1956 prices, is to be raised.

The main task will be to increase the output of oil, chromium, coal, cement and electrical energy, and to start in the last few years of the period the output of iron ore and nickel.

Oil output in 1960 is to be 156% higher than in 1955; that of petroleum bitumen, 414%; refined bitumen, 122%; chromium ore, 246%; and copper, 128%.

Amongst new industrial establishments to be opened during the period are a new oil refinery at Tserrik, a copper smelting plant, an iron and nickel ore mine and a hydro-electric station on the River Mati.

CANADA

Newsprint project

The Great Lakes Paper Co. is to install a newsprint machine with a capacity of over 100,000 tons p.a. at Fort William. The machine which, according to the company, will be the largest in the world, will start production by July 1958. This will be the fourth machine to be installed under the company's new expansion programme.

In 1955, the company produced 155,250 tons of newsprint and 44,056 tons of pulp.

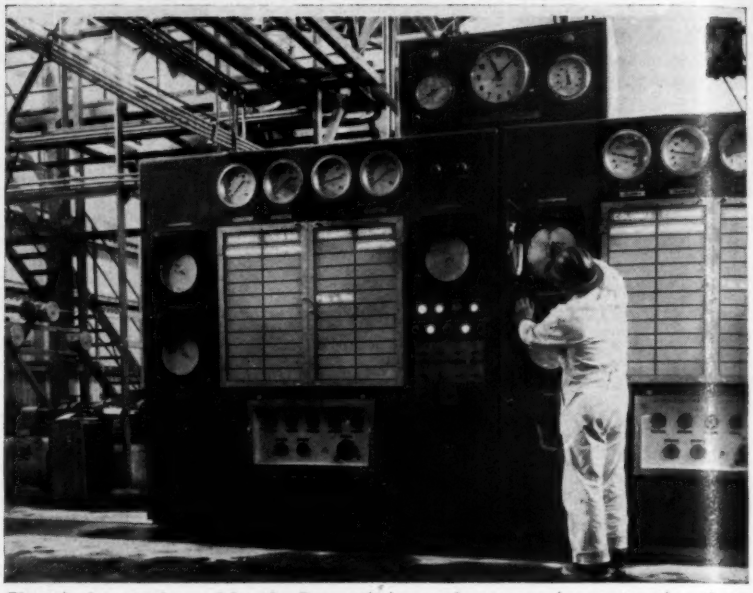
ITALY

Sulphur statistics

Italy produced more than 180,000 tons of crude melted sulphur last year, a decline of more than 20,000 tons compared with 1954, according to official statistics issued in Rome. Production of ground mineral sulphur totalled 21,000 tons, compared with 23,169 tons in 1954. Total exports last year reached 45,016 tons, against only 526 tons in 1954.

Deliveries in January of this year amounted to 17,361 tons, of which 11,176 tons were exported. Main destinations were France, which took 3,885 tons and Tunisia 2,200 tons.

Although it appears that the general situation in Italian sulphur has improved, stocks of unsold sulphur are still very large. They totalled 332,000 tons at the end of January, compared with 336,000 tons at the end of December.



Electrical control panel for the Permutit ion exchange uranium extraction plant, described in an article in this issue.

BRAZIL

Magnetic alloys for Brazil

Brazilian requirements for permanent magnetic alloys will be fully met by a new factory to be built in the Sao Paulo area. The plant is to be constructed jointly by the U.S. company, W. R. Grace and Eriez S.A., subsidiary of Eriez International Co. of Erie, Pennsylvania. Initial foundry facilities of the new plant will be able to meet existing requirements for magnetic alloys in Brazil and neighbouring countries.

BELGIUM

Ammonia project

The Union Chimique Belge intends to build at Zandvoord a new plant for the manufacture of ammonia using a modern version of the Haber process. Nitrogen and hydrogen will not be made separately, but the mixture of the two gases will be made directly from a mixture of producer gas, water gas and steam. The equipment will allow the use of either powdered coal or heavy fractions of petroleum distillation as raw material.

As reported in *Industrie Chimique Belge* the new plant, which will have a capacity of 80 tons/day of ammonia, is likely to start operations at the beginning of 1958. The costs are estimated at £2 million. Half the amount will come from the firm's own funds, the rest will be supplied by a loan which Union Chimique Belge is getting from Société Nationale de Crédit à l'Industrie.

NETHERLANDS

Polyethylene production

Staatsmijnen in Limburg have decided to go into production of polyethylene by the Ziegler process for which they have bought the licences for the entire Benelux. For this purpose a new factory, which will probably be completed towards the end of 1957, is being constructed at Beek.

RHODESIA

Oil-from-coal investigation deferred

Investigations into the possibility of producing oil from coal in Southern Rhodesia have been shelved for the time being, but they are likely to be reopened in five or six years' time when the Kariba hydro-electric project is 'out of the way,' a Government spokesman said recently.

TURKEY

Industrial projects

The Sümer Bank is planning to spend T.L. 40,000 on increasing the annual output of its present plant by 25,000 tons and T.L. 60 million on a new plant with a capacity of 30,000 tons p.a.

SWITZERLAND

Swiss chemical plant for Brazil

A plant for the production of dyestuffs and pharmaceutical products is to be set up near Rio de Janeiro by the Swiss chemical firms Sandoz A. G., Ciba A.G. and J. R. Geigy A.G., of Basle. Construction work on the new plant will begin in the near future.

Making this announcement at the annual meeting of Sandoz, Dr. A. Stolle, a director of the company, said the decision reflected the desire of foreign countries to attain self-sufficiency in the production of chemicals. In order to safeguard its position on the world market, the Swiss chemicals industry was thus forced not only to expand and modernise its existing plants abroad but to set up new ones.

At present, Sandoz is building a factory in India and is expanding and modernising its plants in the U.K.

EIRE

Avoca copper mine

Tests at the Avoca copper mine in Co. Wicklow have revealed that the deposits there consist of low-grade ore, but that they are very large, according to Mr. H. D. Forman, managing director of Saint Patrick's Mines, Avoca. Overall expenditure on the Avoca mines was estimated at about $8 million. Work started seven months ago and the engineering and planning phases are now complete. The company hope to be in active production before the end of 1958.

Under current plans, it is proposed to ship the ore from the mines through Arklow Harbour, about eight miles away, using an overground pipeline. It is expected that about 40% of the estimated output of pyrites from the mine would be sufficient to meet the domestic fertiliser industry's total requirements.

SPAIN

Mercury deposit

An 'important' mercury deposit is said to have been discovered near Siles in the Calderon mountains in the Spanish province, Jaen. According to the Spanish Cifra news agency, the exact extent of the deposit is not yet known.

PHILIPPINES

Steel projects

The International Steel Smelting & Refining Co. of Manila is to build a pig-iron plant employing the Swedish charcoal process. The company's present operations are confined to a 10-ton arc furnace.

Another project included in the company's expansion programme is the installation of a converter to produce steel ingots.

RUSSIA

Fertiliser projects for Jugoslavia

Under an agreement for the supply of Soviet technical aid and machinery to Bulgaria, the U.S.S.R. will supply the blue prints and machinery needed for the construction of two fertiliser factories with initial annual outputs of 220,000 tons of ammoniac saltpetre and 100,000 tons of superphosphates respectively. They will both be capable of expansion.

The Leonard Hill Technical Group—May

Articles appearing in some of our associate journals this month include:

Dairy Engineering—Continuous Buttermaking Processes; Glass-Reinforced Plastic Cowls for Electric Delivery Vehicles; The 'Jones' Bulk Starter System; Handling Crated Milk with a Power Tug; Milk Sterilisation Plant for the North Staffordshire Co-operative Dairy; The Early Days of Railway Milk Transport.

Corrosion Technology—Corrosion Research Laboratories, 10: British Insulated Callender's Cables; Lanolin as a Temporary Protective; Salt-Glazed Vitreous Clay Pipes; Corrosion Problems on the Texas Gulf Coast, 2.

Paint Manufacture—Recent Developments in Epoxy Coatings; Antifouling Paints Today; Maleic Modified Drying Oils; Instruments for the Paint Industry; Progress in Instrumentation in Paint Factories.

Food Manufacture—Modern Malt Products; Trace Elements in Foods, 1; Olive Products in California; Fermentation Test for Detecting Preservatives in Foods; Safety First with Food Machinery; Microscopical Technique for the Food Analyst, 2.

Manufacturing Chemist—Glycyrrhetinic Acid; Lauryl Alcohols—Manufacture and Uses; Steroid Hormones in Body Processes; U.S. National Bureau of Standards Radiochemical Laboratory; Progress Reports: Pest Control Chemicals; Therapeutics; Essential Oils in India; Monsanto Chemicals' New Radiochemical Laboratory.

Fibres—Radioactive Isotopes and Their Use in the Textile Industry; The Roselle Family; Triacetate Fibres—A Survey.

World Crops—Agricultural Developments in Fiji; Small-scale Farming in the West Indies; Mexican Agricultural Prosperity; Pacific Subsistence Crops—Sago.

Atomics—The Use of Sodium and Sodium-Potassium Alloy as a Heat-transfer Medium, 1; Nuclear Power for Commercial Vessels, 1; Reactions of Light Nuclei, 2; The Pressurised Water Reactor as a Source of Heat for Steam Plant, 4.

INDIA

Fifth oil refinery projected

Calcutta has been suggested as the site for the fifth oil refinery in India by the Assam Oil Co. in a new proposal to the Government of India.

The four other oil refineries in India are at Digboi and Vizag and two in Trombay.

Calcutta has been preferred to Digboi for the installation of the company's 1-million-ton refinery because of its potential consumer market. The company in its new proposal has, it is learnt, suggested that the company's present refinery at Digboi is sufficient to meet the petroleum and oil requirements of Assam and the new refinery should be located near a 'sure' market.

If the new proposal of the company for the setting up of the refinery at Calcutta is accepted by the Government of India, a 650-mile pipeline will be put in for transportation of crude oil from Digboi to Calcutta.

Aluminium factory

A Canadian-backed aluminium factory with an estimated annual capacity of 10,000 tons will go into production at Kirakud, in Orissa, in the middle of next year. The factory will be supplied with 25,000 kw. of electricity from the Kirakud Dam project by next year, and production will start as soon as power is available.

The factory will be the biggest aluminium-producing unit in India and will double the country's aluminium production. It is being established with assistance from Aluminium Ltd., of Montreal.

It is understood that the Soviet Union has also offered to help India to develop her aluminium industry.

IRAQ

Help for Jordan superphosphate industry

The Iraq Government recently approved the allocation of a 1-million Iraqi dinar loan to help Jordan finance superphosphate and other development projects, and of 625,000 Iraqi dinars as Iraq's contribution to the Arab League-sponsored Jordan potash project.

MEXICO

Chemicals

An American chemical company has been negotiating an agreement with a Mexican industrial group to provide the 'know-how' and possibly some finance for the construction of an electrolytic caustic-soda plant. Mexico City is mentioned as the site for this new plant.

UNITED STATES

Zirconium expansion planned

The U.S. Government has announced plans for more than doubling production capacity of zirconium. The Bureau of Mines, at the request of the U.S. Atomic Energy Commission, has begun restoring to operating condition the Government's zirconium plant at Albany, Oregon.

Plastics projects:

Temperature-resistant polythene

W. R. Grace & Co. are to construct an $18-million plant near Baton Rouge, Louisiana, to produce a new temperature-resistant type of polythene under processes licensed from the Phillips Petroleum Co. To be manufactured under low-pressure conditions, it will have substantially different properties than the conventional polythene.

The new plant will be near the Esso refinery, which will supply Grace with ethylene, a basic raw material. Designed plant capacity is estimated at 50 million lb. annually.

Rigid-type polythene

The Koppers Co. Inc. will join Brea Chemicals Inc. in constructing and operating a new polythene plastic plant costing more than $10 million. The construction of the plant, to be located in Los Angeles County, California, will start immediately. Operation is expected to begin by mid-1957 with an ultimate capacity of 60 million lb. annually.

Under a contract between the companies, Brea, a subsidiary of the Union Oil Co. of California, will operate the plant with technical assistance from Koppers. The plant will produce a new rigid-type polythene under a licensed low-pressure process which is reported to give the material greater strength and heat resistance. These qualities are expected to broaden the plastic's markets.

Plastics production expansion

An $8-million expansion programme at the Avon Lake, Ohio, plant of the B. F. Goodrich Chemical Co. has been announced by Mr. John R. Hoover, president of the company. Work on the new additions will commence in early June and is expected to be completed by March 1957. A major portion of the new expansion will be devoted to expanding manufacturing facilities for various types of geon polyvinyl resins and plastic compounds. A new boiler plant will also be constructed and there will be some additions to the development laboratories.

Chemical company's expansion

The Commercial Solvents Corporation has announced a $10-million expansion programme for the production of methanol and petro-chemical derivatives this year. This construction will expand the Sterlington, Louisiana, methanol plant and will also provide additional facilities at the Terre Haute Inc. plant.

The company's new nitro paraffin factory went into production during the final quarter of 1955. Full-scale output is expected during the current year. Production of biochemicals were materially improved during last year, it has been announced.

U.S. chemical market

Estimates of this year's scheduled capital expenditures of the chemical and allied products industry are now at $1,426 million, against 1,016 million in 1955, according to the Department of Commerce and the Securities and Exchange Commission. This marks the biggest expenditure for new productive facilities since the build up to meet the Korean crisis.

U.S. tonnage chemical sales continued high, helped by the strong pace of steel production. Caustic soda demand was firm, with a good call for liquid material from the rayon mills. Chlorine was easier to obtain, but some tight spots still existed. Rising copper prices caused a ten-cent boost in copper acetate to 53 cents/lb. Lithium hydride dipped $1 to $11/lb.

Lower-priced imports brought antimony oxide down to 27 cents/lb. for a two-cent reduction. Ethyl acetate in cans was raised five cents to 35 cents/lb. Deliveries of nickel sulphate are being made more promptly now than a few months ago. Demand for sulphuric acid continues brisk, assisted by the call from petroleum refiners.

Ultrasonics

(*Concluded from page* 175)

there is perhaps a case for a complete critical survey of this subject which could be combined with a repetition of some of the old experiments under carefully controlled conditions. One cannot help a suspicion that some of the experimental results reported in literature are those of electronic engineers or physicists whose knowledge of colloid chemistry or brewing or wool scouring (all subjects for sonic processing) cannot have been as all-embracing as seems necessary for effective evaluation.

The much more reasonable cost of the English book is a credit to the publishers. J. E. GOODMAN

Recent Publications

Dust control. An illustrated, 72-page publication (No. 2004) embracing the characteristics, problems and control of dust has been compiled by Sturtevant Engineering Co. Ltd. Dust problems include the removal of atmospheric pollution in the air supply to ventilating plants installed in public buildings and factories of all sizes and types; the cleaning of furnace gases from power stations, cement works, chemical and metallurgical works; and the elimination by comprehensive exhausting plants of the material constituting serious risks to the health of workers in certain manufacturing processes, including those in atomic research establishments.

Controlled crystallisation. From the Power-Gas Corporation Ltd. comes a well-produced, illustrated publication dealing with the *Krystal* process. The *Krystal* apparatus has been adapted to suit all problems of crystallisation and is fabricated in many different designs to meet the variable conditions encountered in industry, but in all units the container for crystal growth has certain common elements of design. A supersaturated solution of uniform temperature is conducted upward through a dense bed of crystals, which are held in suspension by this upward flow of liquor. This arrangement provides an automatic classifying action, as the largest crystals are suspended in the bottom layer of the bed and the smallest crystals in the top layer, with the intermediate sizes between. A number of applications are described and illustrated, and a French translation of the text is included.

Syntactic foams are low-density structural materials which can be used in heat or sound insulation, or where reasonable strength is required without incurring an excessive weight penalty. They can also be used for producing stable and durable flotation units. In their uncured state they are putty-like in consistency and can be moulded into shape, trowelled on to suitable surfaces and forced into cavities, as well as pressed in sandwich core constructions. They are dealt with in an information sheet issued by Bakelite Ltd.

Infra-red spectrophotometer. A brochure demonstrating the performance capabilities of the model 21 double-beam infra-red spectrophotometer in the various spectral regions is now available from the Perkin-Elmer Corporation, U.S.